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EDITORIAL

THE REDISCOVERY OF LOST PROPERTIES OF ECONOMIC CROPS

THE bulletin on the South American potatoes and their breeding value recently issued by the Imperial Bureau of Plant Genetics refers to the geographical method of plant breeding. " The method is based on the fact that the number, range, and variety of forms of a given plant increases as we approach the locality in which it has originated and from which its various forms have emerged. In these centres of origin it is often possible to find characters or combinations of characters entirely unknown in the plant in question as it appears in other areas, and it not infrequently happens that these characters are of economic importance, and being dominant in inheritance would not be obtainable in any other way of breeding."

The first planned exploitation of this principle was undertaken by an expeditionary band of investigators who were sent from Leningrad in 1925 and spent three years in South America, the original home of the potato, studying the conditions in which the potato grew there and the forms and characters which those conditions have produced. They found that its habitation ranged over 60° of latitude on either side of the Equator and all the way from sea level up to the snowline on the mountains. Corresponding to this wide range of environmental conditions a whole series of distinct specimens of the plant, often sterile on crossing, were discovered by the Russian scientists. Naturally if a potato ever existed which was adapted to any particular set of conditions it was found in this series.

Thus a rich harvest of knowledge was gathered, and the application of this knowledge to the further adaptation of the potato to the varying conditions of Northern Europe is now being worked out in Russia. The most important result that is expected to be achieved is the production of a variety of the crop that will resist both frost and the potato blight, which have been regarded as important factors which set a limit to the cultivation of this valuable crop. It was hitherto assumed that with the appearance of the first frosts of Autumn the potato crop was doomed. No cross between the slight variations of the domestic potato produced the quality of frost resistance and the farmer was helpless against a serious attack of the blight. In South America, however, it was found that the high mountain potatoes were frequently exposed to severe frosts and remained undamaged, while many varieties were unaffected by the blight. It is believed that by crossing the domestic potato with these varieties a type may be evolved which will retain the full cultivated flavour of the former and the full survival value of the latter.

These genetical discoveries are of no little value to this Island. They point the way to new lines of enquiry in regard to the introduction of commonly grown temperate crops in the Tropics if these crops had a tropical ancestor at any time in the remote past. All that is necessary is to trace the home of that ancestor. The possibilities with regard to the potato itself are very considerable. At present we are making attempts with doubtful success to introduce the *Solanum tuberosum*, or the domestic potato of Europe, to the higher altitudes of the hill country. But success on a scale hitherto unsuspected may be achieved if this variety is crossed with an allied type from the equatorial lowlands of America. The principle of what may be called the introduction of new blood is of no less importance to crops that are already established in the country. The rubber plantations in the East, for instance, did not originate from the scientific selection of the best available planting material. It is possible, or rather it is very probable, that in the forests of Brazil there are even now variations from the normal which can impart valuable qualities to our own plantation Hevea—very high yield, for example, or resistance to all forms of disease. In short the subject is worthy of the special attention not only of our Department of Agriculture but also of our three crop research institutions.

AGRICULTURAL IMPLEMENTS*—V

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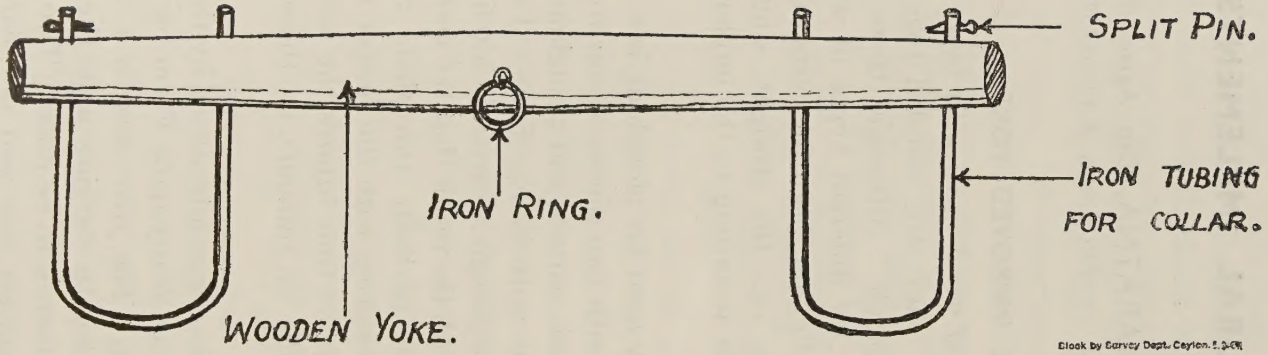
THE IMPROVED YOKE

A YOKE is a frame of wood fixed with bows over the necks of cattle whereby they are coupled together and harnessed to the plough. Although there are different kinds of yokes suitable for different types of work, only one kind of yoke is used in Ceylon, both for carts and for working agricultural implements, *i.e.*, the straight, single yoke. The length of the yoke varies according to the implement for which it is used.

The yoke commonly used for ploughing is a straight, single one four feet in length with two pieces of coir rope to serve as throat bands ; enthusiastic carters and ploughmen use fashionable plaited bands made with hemp string. For heavy work like ploughing, unless the plough is carefully hitched to the yoke, this may turn on itself with the result that the neck ropes become tighter and the animals partially throttled. Sometimes the yoke gets displaced, interfering with the proper working of the implement, and at the same time injures the necks of the bullocks to cause yoke galls or tumours, as these are generally termed.

An improved yoke has been introduced by the writer. This yoke has been used in the Wariyapola Farm for over six years with satisfactory results. The yoke used is a single, straight, well-balanced one, the length varying with the implement to be used with the type of work to be done. Two U-shaped iron tubes, $\frac{3}{4}$ or 1 inch in diameter, are used as collar bands instead of ropes. Second-hand water pipes serve the purpose very well. Each U collar is about 7 to 9 inches wide and about 15 to 18

* This series of articles describes a number of simple implements used in India and Ceylon which are suitable for general adoption by the village agriculturist—*Editor, T.A.*



THE IMPROVED YOKE

inches deep. Small collars are used for local black cattle and larger ones for heavier bulls of the Hissar type. The collars are fastened to the yoke by split pins inserted through the hole at each end of the collar. The split pin is inserted parallel to and alongside the yoke lest the necks of the animals be injured. An iron ring in the middle of the yoke completes it.

Among the advantages of this improved yoke are that it is securely maintained on the necks of the animals and that it cannot roll about. This method of yoking balances the weight properly on the body of the animals and enables them to use their full force in effecting the draught. This is particularly so in the case of buffaloes as these animals have no hump to keep the yoke in position when at work.

The selection of the proper sized yoke for intercultivating operations is important. The size of the yoke depends on the width of the rows of plants to be intercultivated. If the crop is sown in rows 3 feet apart then the yoke should be 6 feet from the centre of the neck of one animal to that of the other. Allowing 6 inches on either side, the yoke should be 7 feet long. If the crop is sown 2 feet apart, then the yoke should be 5 feet long. A convenient formula to work out the length of the yoke required is to multiply the width of the row by 2 and add 12 (the result in inches). For intercultural operations one long yoke with several sets of holes drilled will serve for differently spaced crops. The usual plough yoke is 4 feet long.

A common mistake made in hitching an implement to the yoke is to pass the draught chain round the yoke instead of fastening it to an iron ring. The iron chain has a tendency to cut into the yoke with the result that in a few months the yoke breaks. It is very important that the animals should be well muzzled when they are to be yoked to the plough or to any other implement to prevent them picking up various palatable foods whilst working. This interferes with the work, and is most annoying, particularly when intercultivating operations are being done.

The double yoke is very commonly used in India for ploughing and for working the mhot.

IMPROVEMENT OF CATTLE—II

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IN a previous article* it was stated that improvement of cattle could not be obtained if attention was paid only to the breeding of better stock; attention must also be paid to improvement of the environmental conditions under which the cattle will be required to live.

The improved cattle obtained by breeding from superior strains will require more or better food if they are to thrive. Certain means whereby the food supply for cattle in villages could be improved were indicated.

Up to the present the method of improving the food supply for village cattle which has received the greatest attention is the popularization of the practice of growing fodder grasses. A number of excellent varieties of such grasses have been introduced into Ceylon and have proved suitable for our conditions of soil and climate. Their extended cultivation is highly desirable but it must not be thought that fodder grasses alone will solve the problem. For example, a ration consisting entirely of succulent fodder grass will not, on account of its very bulky nature, be ideal for a draught bull required to do heavy work, neither will it be suitable for a heavy milking cow. At certain stages of their growth, particularly during periods of ample rainfall, a ration composed solely of fodder grasses is apt to be too succulent and may cause diarrhoea. At such times some foodstuff which will counteract this tendency must be fed along with the fodder grasses. Outstanding examples of foodstuffs suitable for this purpose are cotton seed and paddy straw both of which are available in Ceylon but which are not used to

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anything like the extent they might be. Cotton seed is a very suitable addition to the ration for working bulls and milking cows but should be very sparingly used in the feeding of calves and young stock. In many parts of Ceylon little care is taken to preserve the supplies of paddy straw available at harvest time. There seems to be an unwarranted prejudice against it in many parts of the country, particularly among owners of dairy cows. One often hears the opinion expressed that it causes a decrease in the milk yield. There is no evidence to support this belief but there is good evidence against it.

In Shanghai, in a very large and successful commercial dairy stocked with cows imported from Australia, America and Great Britain, great difficulty was experienced in obtaining supplies of good fodder. It is understood that this difficulty was solved by extensive use of paddy straw with very good results.

In the dairy attached to the Farm School, Peradeniya, paddy straw has been incorporated in the ration on an increasing scale during the past two years with satisfactory results. It seems to be very palatable and is readily eaten by the cows. This fact was strikingly demonstrated when two pedigree Aryshire heifers were imported from Scotland a year ago. Among other foodstuffs sent with the heifers on the ship was a supply of the best quality oaten straw. A few bales of this remained unused on arrival at Colombo and we were very careful to obtain them and take them with the heifers to Peradeniya. Our anxiety to take this oaten straw from the ship was on account of the difficulty, well known to all cattle owners, so often encountered in inducing cattle to take readily to any foodstuff to which they have not been accustomed. To our great surprise we found that these heifers when fed with a mixture of their native oaten straw and our Ceylon paddy straw picked out the paddy straw and rejected the oaten straw. The preference shown was very marked and we have continued to feed paddy straw in quantities up to 5 lb. per day to these heifers ever since. That it did not have any ill-effects on the milk yield was shown by the fact that one of the heifers has since calved and has given 4 gallons of milk in one day which is considered satisfactory for a first calf heifer of the Ayrshire breed.

In view of these facts it is very disappointing to observe how little attempt is made in many parts of the Island to make full use of the supplies available. Badly-made stacks of straw which are quickly damaged and spoiled by rain are too commonly seen. Much larger weights of straw could be obtained if it be cut closer to the ground. It is no uncommon sight to see a stubble of over one foot in length left after harvesting.

During prolonged periods of dry weather the rate of growth of fodder grasses slows down and an area which is ample during wet weather to supply the needs of the owner's herd becomes inadequate. Some cheap foodstuff to supplement the diminished supply of fodder grass during such periods is necessary. The drop in the yield of the fodder grasses could, of course, be obviated by irrigation but this is seldom practicable. Possible supplements which are worthy of trial include cassava and the juicy stems of plantains.

The great value of the roots of cassava as a standby during long periods of drought has been emphasised by Stewart, Principal Veterinary Officer in the Gold Coast, during the past few years. That cattle would eat the roots of cassava if they had access to them was fairly well known but they had never been used to any extent as a cattle food chiefly because of the fear that poisoning would result.

Stewart's experiments showed that the danger was greatly exaggerated if reasonable precautions were taken. He found that cattle readily eat the chopped roots and improved in condition when fed on them. He considered cassava roots the cheapest and best foodstuff for use during the dry season. On one of the Government Farms in the Gold Coast he used up to one ton of cassava roots per day for feeding cattle without any ill-effects. In view of Stewart's results, this foodstuff was tried at the Ambepussa Farm. In the beginning it was fed to two young heifers and two goats. A little difficulty was experienced on the first day or two of feeding in inducing the cattle to eat it readily, but this was soon overcome. Fearing possible ill-effects from hydrocyanic acid poisoning we fed only a small amount at first. Beginning with 1 lb. per head per day it was increased daily till the heifers were getting 20 lb. a day. This was continued for a prolonged period without any ill-effects.

The two heifers improved in condition as compared with their companions which were not getting cassava. Since then for over a year chopped cassava roots have been fed to the whole herd whenever supplies were available. No cases of poisoning by cassava have occurred during that period. The crop is easily grown, the chief difficulty which has been experienced has been damage by porcupine. As an easily grown and useful supplementary feed for use in the dry season it is well worthy of extended use in Ceylon. In using cassava as a cattle food, the chief point to remember is that it must be fed fresh. Only sufficient for one day's supply should be dug at a time. It must not be dug up and stored for future use. The roots should be chopped and fed to the cattle as soon after digging as possible. A suitable method of using them is to feed the chopped roots in the evening when the cattle return from grazing. A turnip pulper as used in Europe for chopping turnips for feeding to cattle has proved very suitable for chopping cassava roots and saves a great deal of labour.

Plantain stems cut into slices are readily eaten by cattle and where available are a very useful supplementary feed especially during dry weather when succulent foods are very scarce. In some parts of Tanganyika where grazing lands are very scarce certain tribes are stated to maintain their cows almost entirely by stall feeding. The cows spend practically their whole lives inside the sheds. They are fed on weeds collected from the cultivated areas, and on grasses cut and collected by the women. Every third day a plantain tree is cut down. The stems and leaves are cut into thin slices for the cattle. All banana skins are also fed to the cows.* The cows maintained in this fashion are said to be small in size but are healthy, in good condition, and supply their owners with milk for their household.

There are few places in Ceylon where conditions for cattle are more adverse than in such parts of Tanganyika and such an example shows what can be done even under the worst conditions when the cattle owner is prepared to exert himself.

(*To be continued*)

* Annual Report, Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, 1935

COIX GIGANTEA (LINN.)—WILD ADLAY

A PERNICIOUS PADDY FIELD WEED

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WEEDS IN RELATION TO AGRICULTURE

THE successful cultivation of any crop depends on the issue of a battle waged between the crop and various foes both visible and invisible. Pests and diseases in any form are debilitating and destructive to cultivated crops. Climatic and weather conditions, though they sometimes prove hostile, are not within the power of the farmer to bring under subjugation, but by due application, pests and diseases can be brought under control or fully exterminated. Not the least of a farmer's enemies are weeds, which add enormously to the cost of crop production. Although weeds are responsible for nearly halving the yields of many crops, yet adequate attention is not paid in most countries to their control. According to a report by the Agricultural Service Department Committee of the United States Chamber of Commerce, annual losses from weeds considerably exceeds the combined losses sustained from animal and plant diseases and the depredations of insects, rodents and predatory animals. The rank growth of weeds invariably found in paddy fields is largely responsible for the low yields obtained from paddy, the most important food crop of the indigenous population in Ceylon. In the field, weeds set up an incessant competition with the main crop for plant food, light and water. Weeds, especially graminaceous herbs, very often harbour insect pests and diseases inimical to paddy and also add to the cost of labour.

According to the writer's experience the effect of *Coix gigantea* in paddy crops is greater than the combined damage done by all other paddy field weeds. *Coix*, being a cereal, demands the same kind of plant food as is required by paddy

A full-grown wild Adlay plant in seed

Wild Adlay standing erect, whereas the paddy crop has lodged heavily

A paddy field overrun with wild Adlay

and, in the struggle for food absorption, the paddy crop is greatly handicapped, owing to its poorer root-system. The writer first noticed this weed in the Kegalle range but, on further investigation, found that it existed in large areas in the North-Western Division and South-Western Division. Many paddy fields in Kegalle have been gradually caught in the grip of this pestilential weed, and a close survey of the areas, combined with collated evidence, indicates that the weed started spreading from the Kurunegala and Negombo Districts towards the Kegalle District. Like tares of biblical fame, *Coix* is used by many villagers as a means to punish a fellow villager, by throwing a handful of the seed into his paddy field, with the happy knowledge that it will multiply through generations, ultimately throwing the field out of cultivation.

DESCRIPTION

Coix gigantea is a very hardy, graminaceous annual or perennial herb of the tribe Andropogoneae and sub-tribe Maydeas and is a wild form of the edible cereal, adlay, *Coix lachryma-Jobi*, commonly known as Job's tears. Unlike adlay which grows to about 3 to 6 feet in height, this wild species is tall, often reaching 10 feet or more. It is more robust than adlay on reaching maturity becomes very woody, the lower nodes often measuring half inch or more in diameter. It stands ratooning like the cultivated species. Its leaves are longer and narrower than adlay, bright green and taper from a broad base to an acuminate tip, with serrulate margins. In bright sunshine, the glossy leaves contrast sharply with the dull leaves of paddy. Like adlay, *Coix gigantea* is monoecious. The speciform terminal or axillary racemes are sparsely branched, and are longer and more drooping than those of adlay ; each raceme consists of a female spikelet at the base, surmounted by a series of male spikelets, usually 3–nate at each node. The female spikelet or fruit or seed as it is often called, is enclosed in a broadly ovoid, acuminate, stony bract, which on ripening becomes hardened, highly polished and nut-like, and has a colour ranging from grey to pale brown to mottled chocolate.

The fruits keep very well and are often used in making rosaries, ornamental trays, baskets, boxes and bead-curtains.

The enclosed grains can be fed to poultry after crushing the fruits. The stems, normally tinted reddish brown, are freely branching, very stout, smooth and polished, and root at the lower nodes. Wild adlay does not tiller so freely as the cultivated species, produces fewer female spikelets and possesses a more vigorous root-system. Specimens removed from cultivated paddy fields had a more efficient root-system than surrounding paddy plants, the feeding range being much wider, spreading as it did from $1\frac{1}{2}$ feet to 2 feet. Examination of the root-system revealed that there were clearly two types of roots—a slender fibrous type, densely covered with absorbing capillaries, originating from the base of the plant and long, cylindrical roots radiating from the base and lower nodes. The roots arising from the upper nodes act as props to the plants in assisting them to withstand the force of flowing water or wind, while the less adapted paddy lodges heavily under such environmental conditions. The submerged parts of the roots are spongy and pithy serving perhaps as breathing organs. Wild adlay growing on dry land does not possess this characteristic.

CONTROL AND ERADICATION

It is of paramount importance, in the interest of paddy cultivation in Ceylon, to arouse concerted action in the control and eradication of this weed, as its spread is becoming general and its effect in the reduction of crop yields is considerable. Several fields have been seen in which this weed so predominated over the paddy crop, that the cultivators gave up harvesting the crop altogether. In badly infested areas paddy plants bear few grains and the expenditure in harvesting is greatly increased, as selective reaping has to be resorted to—in itself is a laborious task.

It was noted that wild adlay needs 5 to 6 months to flower and seed and hence it matures only during the *maha* season—when long-age paddies are sown in these fields. Although it grows with short-age paddies when sown during *yala*, it has no time to reach maturity, flower and seed and the plants are harvested with paddy crops before seeding. Seeds start sprouting the fields about 3 to 4 days after the paddy crop is sown and at a time when the field is devoid of free water and when the mud is warmed by direct solar heat.

Field observation and pot experiments revealed the fact that when fully submerged under water, wild adlay seeds do not germinate and, in adopting any control measures, this behaviour of the seeds should be taken into consideration. Viability of the seed is very great, so that seeds may remain dormant underground for considerable periods to germinate as soon as suitable conditions arise. The seeds are heavy and sink in water but are nevertheless transported by running water in channels and by overflowing flood water. Rabbing or burning the paddy stubble tends to increase rather than decrease the germination of seeds and it is suggested that the scorching of the stony, hard coat of the seed permits the more easy penetration of water.

When the life history and peculiarities of this plant are considered, it will be realized that if it is to be successfully controlled it requires both communal and individual effort. The campaign should be well organised with a definite programme for attaining the object in view. The measures adopted should be persistently and faithfully executed for several years.

The following control and eradication measures are suggested :—

1. Whenever possible paddy should be grown in both seasons.

2. Transplanting the crop during *maha*. This will give an opportunity to select clean, weed-free seedlings from the nurseries for transplanting. At the same time the rest of the field should be prepared in the ordinary way and left unsown so that the weed when it germinates and grows to an appreciable size can be rooted out and destroyed, or the whole field ploughed up burying the weed seedlings, which could be rotted by flooding. The sprouted seedlings can also be killed by keeping them fully submerged under water for about a fortnight.

3. Fields that cannot be sown during *yala*, for want of sufficient irrigation water should be brought under vegetable cultivation, when the wild adlay seedlings can be easily removed as they appear.

4. Flooding the paddy field as soon as paddy seedlings can tolerate a stand of water ; such a treatment will prevent

the seed from sprouting and if already sprouted, will kill them if they are kept submerged for a considerable period.

5. Cutting out the weed, when it has reached an appreciable size and flooding the field to kill out the root-stock. The green material can be fed to cattle.

6. Thorough weeding.

7. Use of clean seed.

8. The collection and destruction of seeds that have dropped before or during harvesting.

9. Removal of the weed if found growing on highland in the neighbourhood of paddy fields.

10. If other methods fail, the short-age paddies may be grown during both *maha* and *yala* seasons to prevent the weed from seeding.

DIFFICULTIES ENCOUNTERED IN THE CONTROL OF WILD ADLAY

1. Owing to the close similarity of wild adlay seedlings with paddy seedlings the plants are overlooked and left behind during the process of weeding.

2. Owing to the strong root-system, seedlings may break away during weeding operations, leaving the root-stock behind to shoot out again.

3. Flowering and seeding of wild adlay often coincides with that of the paddy crop and most of the seeds drop off before or at the time of harvest. In consequence the weed multiplies very rapidly.

4. No cultivator can be induced to enter the paddy field and handle the weed, once the paddy has advanced in growth.

5. Owing to their great viability, seeds remain dormant for a long period, till favourable conditions appear for germination.

6. Malicious introduction of seed to paddy fields through human agency.

7. Control measure (No. 5) cannot successfully be carried out in paddy fields infested with land crabs, since, as soon as the paddy fields are flooded, crabs become more active and large numbers of paddy seedlings are eaten and destroyed by them.

8. The system of tenancy cultivation, by which cultivators are changed from season to season, militates against conscientious application, hence continuity in control methods is the exception rather than the rule.

DEPARTMENTAL NOTES

SOIL SAMPLING

A. W. R. JOACHIM, Ph.D.,
AGRICULTURAL CHEMIST

THE modern method of soil sampling is based on the soil profile, which is a vertical section of the soil from the surface down to parent rock or undifferentiated soil material. A soil profile consists of various layers or *horizons*, termed respectively the A, B and C horizons. The A horizon is the soil proper and is generally darker in colour than the underlying B and C horizons, due to the accumulation of organic matter. It may be divided into sub-horizons designated A1, A2, etc., according as to whether the intensity of the colour varies or not.

The B horizon is the soil layer into which material from A is washed down and deposited. It may thus be darker in colour or be more gravelly than the lower part of the A horizon. This also may be sub-divided into B1 and B2, etc. It generally corresponds to what is popularly known as the sub-soil. The C horizon is the partially decomposed or undecomposed rock material or the undifferentiated soil material of more or less uniform colour and texture but of varying depth. Often the B horizon is not present in tropical soils, the A and C horizons only being observed.

The different horizons or sub-horizons are distinguished from each other either by differences in colour, texture or structure. The modern method of soil sampling is according to the depths of the horizons, and not according to standard depths, *e.g.*, 0–9′, 9″–18″ as in the old method. As many soil samples will therefore be taken as there are horizons in a profile.

In selecting a site for soil sampling, care must be taken that it is representative of the area. A preliminary exploration is therefore essential, during which road cuttings, ravines, and other soil exposures in the area are carefully examined. Once a site is selected a trench 3 to 4 feet deep and about 3 ft. by 3 ft. cross section is dug, one side at least being made vertical. A freshly cut hillside adjoining a road would also be suitable, but in this case the face should be cut into the hillside to a depth of 2 or 3 inches before the samples are taken.

At the profile site selected, the following observations are made for each horizon and sub-horizon ; colour and depth ; texture, *i.e.*, whether loamy, sandy, gravelly, clayey, etc.; the presence or absence of quartz or ferruginous gravel, concretions, boulders, etc. and to what degree ; whether it is of the single grain, clod, granular, columnar (rough rectangular with a slightly domed top), prismatic structure ; degree or hardness and compactness ; root growth ; horizon boundary demarcation, whether distinct or indistinct, etc.

The following general information regarding the nature of the area should also be recorded : site ; rainfall and temperature ; topography of area, whether level, undulating, hilly, etc.; mode of formation, whether formed *in situ*, *i.e.*, sedentary or transported (sedimentary) and, if the latter, whether wind-blown or alluvial ; geology of plant material (if known); drainage and nature of vegetation. A typical example of a description of a soil profile is shown at the end of the article.

The soil samples are then taken as follows : a vertical slice of about 3 inch to 4 inch thickness from the side of the profile is cut from the top downwards to the depth of the first horizon or sub-horizon and the soil thus obtained well mixed and a sample of about 2 lb. put into a small cloth bag. On the outside of the bag the identity of the sample is marked in coloured pencil, *e.g.*, A1. A label similarly marked should also be placed inside the bag. The bag is well tied and retained for despatch with others. The B and C horizons are next sampled and separately bagged and labelled. In each case only the actual range depth of soil covered by the horizon in question is sampled. It is not generally necessary to sample the sub-horizons, unless these are very clearly discernible and are required for special purposes.

All the samples from one profile are put into a gunny bag which is well tied and suitably labelled with the name of the place the samples are from, and the number of small soil bags enclosed. When the soils are sent for examination the observational details should also be forwarded. For further information on the subject of soil sampling, reference should be made to *The Tropical Agriculturist*, Vol. LXXXIV, April, 1935. "Studies on Ceylon Soils I.—Modern Methods of Soil Study and Classification and Their Application to Ceylon Soils."

WET PATANA SOIL PROFILE

Horizon boundary indistinct	A 1 0-14″	Black peaty loam ; loose and friable ; irregular columnar ; root growth poor ; acid
Horizon boundary very distinct	A 2 14-25″	Lighter black heavy loam ; compact but friable ; irregular columnar ; roots rare ; acid
Horizon boundary distinct	B 25-32″	Greyish yellow loam forming pan ; quartz and iron stone concretions abundant; conglomerate; hard and compact ; roots absent ; acid
	C 32″-10′	Reddish yellow heavy loam; hard but friable; irregular clod; red mottlings of decomposed ferruginous concretions; acid; roots absent

Kandapola ; 6000 ft. ; 100 in. 60° F ; basic and intermediate metamorphic rocks ; residual ; drainage imperfect ; steep ; bracken, grasses and Rhododendrons.

SELECTED ARTICLES

COCONUT RESEARCH SCHEME

SEED SELECTION*

(" If the work of agriculture is well cared for, then one gets gold out of it ; if, however, agriculture is neglected, then it brings poverty"

—*Mahamuni Parasara*, 1300, *B.C.*).

SEED selection on coconuts can be carried out by any intelligent planter who is willing to take pains. It consists of (*a*) Selection of Mother Palms, (*b*) Selection of Seed Nuts. The selection of mother palms is the more important of the two. (Selection of seedlings in the nursery is considered in Leaflet No. 2).

(a) SELECTION OF MOTHER PALMS

A mother palm should be selected according to the following standards :—

(i). The trunk should be straight and stout with leaf-scars situated close to each other. Avoid very tall and curved trunks.

(ii). The fronds should be short and well dispersed on the crown. The orientation of fronds on the crown can be represented diagrammatically as follows ; it will be noticed that there are three main types.

Types 1 and 3 should be avoided, even if they show other desirable characters. Type 2 displays the best spread of fronds.

(iii). The bunch stalks should be short and should not show any tendency to droop.

(iv). The inflorescences should carry a fair number of female flowers, or button nuts—up to 100. Avoid palms with inflorescences that are overstocked with female flowers. They are not thrifty.

* By W. V. D. Pieris, Geneticist, Coconut Research Scheme (Leaflet No. 1).

(v). The crown should carry a large number of fronds and consequently, a large number of inflorescences. Avoid crowns that look empty on one side, even though the inflorescences that are present on the other side appear to set many nuts.

(vi). It need hardly be said that inflorescences should be well stocked with nuts. But it might be mentioned that inflorescences in all stages should be noticeable on the palm, carrying their full complements of developing nuts. Very often one is deceived by heavy lower bunches.

(vii). The size of nut is not important, provided large numbers are present. A medium-sized nut is produced in the best numbers. Palms with extra large nuts should be avoided.

(viii). The weight of the husked nuts should be high, since on this depends the copra-producing power of the palm. The number of nuts and the weight of the husked nuts provide the best standards of selection.

(ix). Do not select palms growing in favourable situations, such as near cattle sheds and human dwellings, because they will be better than palms growing in the open field in competition with their neighbours merely by reason of their favourable surroundings. Palms that bear well in a normal or even unfavourable environment should be selected.

Once a mother palm has been selected, it is necessary to study its capacity for yield. In order to do this, yield records must be kept for at least three years, during which time it will be possible to test its performance. The number of nuts and the weight of husked nuts of individual palms should be recorded at every pick in a note-book ruled out in the following manner :—

DATE OF PICK :

Field No.	Palm No.	No. of Nuts	Weight of Husked Nuts	Calculated Weight of Copra

The weight of copra is approximately equal to 32 per cent. of the weight of the husked nuts. From the last column it will be possible, at the end of each year, to get a fair estimate of the amount of copra which any particular palm would have produced.

It should be borne in mind that, under fair treatment, a good palm will always remain a good palm and a bad palm will be equally constant in remaining bad.

At the end of three years all selections that have not produced, on an average, 100 nuts and 175 lb. of husked nuts per annum should be rejected. *Wherever possible there should be at least one proved mother palm for every five acres on an estate.* This would not be possible in the case of small-holdings, the owners of which should, therefore, buy the seed-nuts or seedlings they require from large estates or from the Coconut Research Scheme.

(b) SELECTION OF SEED-NUTS

Seed selection does not end with the selection of mother palms. The nuts from these palms should also be selected according to the following rules :—

(*a*). Only dead ripe nuts should be used for seed.

(*b*). First bunch nuts are better than second bunch nuts. But if two bunches must be cut, make sure that the husks of the second bunch nuts have turned brown. Do not use third bunch nuts for seed.

If you are interested in the performance of the daughter palms in relation to the mother palms, as you should be, keep the nuts from the different palms and bunches separate and number each nut according to its mother palm number and bunch number ; and when planting the nuts in the nursery, be careful that the nuts do not get mixed. Pegs should be used to mark the palm and bunch numbers. When the seedlings are put in the field, they should carry individual numbers stamped on zinc tabs. The tabs could be tied on with wire to the seedlings when they are being transplanted, but later they should be fixed to wooden pegs driven into the ground.

The extra work involved in carrying out the suggestions made in the last paragraph will be well worth while, because in a few years, when the daughter palms come into bearing, you will be able to compare their performance with that of the mother palms.

Seedling Selection and Transplantation will be discussed in a later leaflet.

NURSERY MANAGEMENT AND SELECTION OF SEEDLINGS*

COCONUTS should not, as a rule, be planted out directly in the field since :—

(*a*) Seed nuts do not all germinate at the same time, and late germinations, which would be rejected in the nursery, would be allowed to remain in the field. It is believed that seed nuts which germinate slowly give rise to palms which are equally slow in coming to maturity.

(*b*) The selection of seedlings for characters other than early germination would be prevented.

(*c*) Watering, which is necessary during the early stages of growth and which can be carried out easily in a nursery, would be much more difficult and expensive in the field.

(*d*) It will be extremely difficult in the open field to keep a check on the various pests and diseases that attack coconut seedlings during their early life, whereas in a nursery this would be a fairly easy matter.

II. *Location.*—Nurseries should be on sandy or light loamy soil, free from water-logging, but close to a source of water like a well or a stream, away from heavy shade, and, if possible, close to the area which is to be planted up.

III. *Seed Beds.*—The nursery-beds should be long and narrow in order to facilitate watering when necessary and should be raised 8 to 10 inches above the general ground level. Beds should be separated by shallow drains, which join up to form a leader-drain for carrying away excess water during rains.

It is hardly necessary to add that the soil in the beds should be free from stones, coconut roots and weeds. The presence of coconut roots and other decaying organic matter in the soil encourages termites which are quick to attack germinating coconuts and coconut seedlings.

In permanent nurseries, the edges of the beds should be turfed ; otherwise, they will get damaged during rains and fall in, blocking up the drains as a result.

After the soil in the beds has been levelled, it should be compacted with an ordinary wooden compactor or a light garden-roller.

IV. *Spacing.*—The spacing of the nuts in the beds will depend on the length of time the seedlings are intended to be kept in the nurseries after they have germinated. The longer the period, the wider should be the spacing. As a general rule, it is unwise to keep seedlings too long in the nurseries, because

* By W. V. D. Pieris, Geneticist, Coconut Research Scheme (Leaflet No. 2).

once the roots have passed out of the husk and penetrated into the soil, it is not possible to take the seedlings out for transplantation without subjecting them to a more or less serious shock due to root damage. The ideal to aim at is to remove the seedlings before the roots have entered the soil. This is not always possible in practice, especially if seedling selection in the nursery is intended, when the seedlings have to remain in the nursery until they have developed at least two foliage leaves.

If it is desired to transplant the earliest sprouted nuts before any root have passed out of the husk into the soil, that is, when the sprout is about an inch long, seed nuts could be put down very close to each other, less than six inches apart. There will be no competition for food, moisture or light at this stage and the spacing distance will, therefore, be of little account. When transplanting at this stage, it must be borne in mind that only those nuts should be taken that have germinated within three months of the date of planting in the nursery.

If one intends to transplant when the sprout is 4 to 6 inches long or at the 2nd-leaf stage, seedlings should be spaced 9 to 12 inches from each other.

In laying down a nursery, always try to make a neat job of it. Let the rows be straight and the spacing regular. It is much easier, quicker and safer for the seedlings, to be able to walk up and down a straight row when one has to water them, or hunt after leaf-eating caterpillars or use a spray against scale-insects, than to pick one's way over an irregularly planted seed-bed.

We have found it convenient to cut long straight trenches down the beds, spaced 9 inches apart and about 6 inches deep, in which the nuts are placed at the correct distances and covered over with soil.

V. *Position of Nuts.*—Nuts should be planted flat or on the side and not upright. Our experiments have indicated that the seedlings that develop from nuts planted upright suffer more from drought and are less robust than those that develop from nuts planted flat.

After the nuts have been positioned, they should be covered over with soil and not left exposed. The number of nuts planted in the nursery should be at least 50 per cent. or if possible 75 per cent. more than the required number of seedlings. We ourselves reject about 50 out of every 100 seedlings in our nurseries at Bandirippuwa Estate.

VI. *Germination and Growth Records.*—Seedlings for transplantation should be selected in relation to the following characters :—

(*a*) Early germination

(*b*) Rapid growth

(*c*) Sturdiness and freedom from what is known as "legginess."

The good nurseryman will study each seedling separately. For this purpose, it is necessary to number nuts in relation to the parent palms, the numbers being painted on the nut with tar. For instance, if the nut is the 3rd

nut of the 1st bunch of the 52nd palm of the 6th block on the estate, the number on the nut should be VI-52-1-3. If it is the 7th nut of the 2nd bunch of the 39th palm on the 3rd block on the estate, the number should be painted, III-39-2-7, and so on.

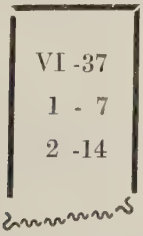
A note-book should be ruled out as follows and the data regarding the nuts and subsequent seedlings should be entered against each individual number. The suitability or unsuitability of the seedlings for transplantation should be stated in the last column.

NURSERY RECORD

Date of Planting in Nursery.....

Block No.	Palm and Bunch No.	Nut No.	Date of Germination	No. of days taken for Germination	General Remarks on Seedlings

Since the numbers on the nuts will not be visible once they have been put down in the nursery, it is a good plan to have pegs to indicate the nuts from each palm. The number of the palm and the number of nuts from each bunch should be painted on the peg, together with the Block number, as follows :—



which means { Block VI, Palm 37. / 1st Bunch 7 Nuts / 2nd ,, 14 ,,

Coconuts germinate in three to four months, and develop two or three leaves about two months after germination. As a rule, the sprout is developed and appears through the husk some time before the roots pass into the soil. The first roots emerge from the husk when the sprout is a few inches long ; and when the first two or three green leaves are developed, not many roots are found to have entered the soil.

VII.. *Seedling Selection.*—Seedlings are transplanted at one of three stages, *viz.* :—

(*a*) As soon as the tip of the sprout appears through the husk or when the sprout is about an inch long.

(*b*) When the sprout is 4-6 inches long, but before any green leaves have developed or any roots have entered the soil.

(*c*) When the first two or three green leaves have developed.

At the first stage, the sprouted nut could be removed to the field without doing any damage to the roots, but it is impossible at this stage to say whether the subsequent seedling will be robust or weak, well developed or deformed.

At the second stage too root damage is small and the seedlings have the added advantage of a higher survival value than seedlings at the first stage. But at this stage also, the characters of the fully developed seedling cannot be studied and used as a basis for selection.

It is only at the third stage, that a seedling can be properly studied and reliably selected according to all the standards laid down, *viz.*, Earliness of Germination, Rapidity of Growth and Sturdiness. Data regarding earliness of germination will be found in the Nursery Record Book, mentioned above, and rapidity of growth and sturdiness could be quite easily gauged by eye or by measurement.

The two expressions " sturdiness " and " legginess " might now be defined.

A sturdy seedling grows up straight, has a stout " stem, " and dark-green, broad leaves, with stout midribs.

A leggy seedling is often curved in growth, has a thin, weak " stem, " and pale-green, narrow leaves, with thin midribs.

Some caution must be exercised in selecting seedlings for height alone, since it sometimes happens that leggy seedlings are taller than sturdy seedlings.

VIII. *General Care of the Nursery.*—No weeds should be allowed to remain in nurseries, especially during drought. Watering should be done once a day during dry weather. No manufacturing of nurseries is necessary. A careful lookout must be kept for pests and diseases.

Fortunately, in Ceylon we are not troubled greatly with coconut seedling diseases, except very occasional outbreaks of grey-blight, *Pestalozzia palmarum*. Some damage is done by scale-insects, *Aspidiotus destructor*, termites and various species of leaf-eating caterpillars, including the coconut caterpillar, *Nephantis serinopa*, nettle grubs, bagworms and the larvae of the butterfly, *Elymnias fraterna*. Notes on the control of scale-insects and termites are given later. Caterpillars on seedlings can be controlled by hand-picking or by spraying with lead arsenate at the rate of 1 oz. of the powder in every 2 gallons of water.

Grey-blight causes yellow or brown oval spots, up to $\frac{1}{2}$ inch in diameter, which dry up in the centre and become typically grey. Protection against the

disease may be obtained by spraying at intervals of about a fortnight with a reliable copper fungicide. Colloidal copper (1 oz. to 1 gallon of water) is a convenient fungicide, since it is easy to prepare and relatively cheap. The addition of soft or yellow soap, at the rate of 1 oz. to 1 gallon of the spray mixture, ensures good spreading of the spray. A sprayer of the 'Flit' type is adequate for small plants, but in large nurseries a pneumatic knapsack sprayer is desirable. Spraying should be done in the early mornings or late afternoons and *it is necessary to see that both sides of every leaf are wetted with the spray.*

An attack of scale insects will be observed by the appearance of yellow spots on the leaves accompanied by the presence of the insects themselves on the under-surfaces of the leaves. Precautions must be taken at the very first appearance of the insects and the plants should be sprayed with kerosene emulsion, which is quite easily prepared as follows :—

Common laundry bar soap ..	½ lb.
Soft water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the water by shaving it into hot water over a fire. Remove vessel from fire and add the kerosene, stirring thoroughly. Then churn up the mixture by drawing it up into a garden syringe and forcing it back into the vessel. Keep this up until the mixture becomes creamy and begins to thicken. If it does not thicken fairly soon, it may mean that the water is too hard. Add a little borax or soda to soften the water, but this should be done at the start if the water is known to he hard. The mixing is completed when the creamy mass begins to go hard through the pump. The resulting cream or emulsion is your Stock Solution and for applying to the plants mix 1 part of the Stock with about 9 or 10 parts of water.

TERMITES

There are two subterranean groups of termites known to attack coconut palms at various stages of their growth.

(1) The mound-building termites, notably *Cyclotermes redemanni* and *Hypotermes obscuriceps.* These are the so-called scavenging termites which feed on dead and decaying plant tissues. They sometimes invade nurseries or individual seedlings in the field to feed on portions of the husk and may injure the growing roots if these are not healthy; and, in so doing they may possibly hinder the growth of healthy roots.

Mound-building termites come from a main mound-nest which may be some distance away, and they may start new nests around or near the seedlings. Such nests eventually become mounds.

These termites have to maintain a continuous connection with a main or subsidiary nest.

Treatment.—All mound-nests should be treated according to the instructions given below.

The diameter of the base of the mound to be treated must be obtained first. The mound should then be levelled, and one hole should be drilled in the area previously covered by the mound to every 6 inches of diameter measurement, the holes being distributed evenly over the area, and being about 12 inches deep. 1 oz. of petrol should be injected into each hole.

Thus the area covered by a mound, 18 inches in diameter, would require 3 holes and 3 ounces of petrol, while the area occupied by a large mound, 6 ft. in diameter, would require 12 holes and 12 ounces of petrol. The cheapest method of application is to drill the hole with a crowbar and pour in the petrol through a funnel fitted with a long neck or rubber tubing. When funds permit, a Vermorel " Excelsior " Injector can be used with advantage, as the dosage can be automatically regulated and the holes drilled by the instrument itself.

The treatment of individual attacked seedlings is given in (2) below :—

(2) Termites that build no mounds, species of *Coptotermes*. These termites live underground and feed on living, healthy tissues, and are occasionally known to attack coconut palms and seedlings. A small underground nest may be near each individual attacked palm.

Treatment.—For the treatment of individual seedlings attacked by termites mentioned in (1) or by species of *Coptotermes*, a soil fumigant such as paradichlorobenzene (P.D.B.) is recommended.

Apply at the rate of 1 large heaped teaspoonful or about $\frac{1}{4}$ oz. per seedling, mixed thoroughly with 1 cigarette-tin full, or $\frac{1}{2}$ lb. of fine soil or sand to give an even distribution. Sprinkle the mixture thinly and uniformly in a shallow, circular furrow with a radius of about 6 to 9 inches from the seedling or base of palm and cover over with soil.

THE ROOT-EATING ANT

This is a true ant *Dorylus orientalis*, although sometimes mistaken for a termite. *Dorylus* is a small, slender, reddish-brown ant, the " workers " of which are about one-fifth of an inch long, which eats healthy roots of a great variety of plants and riddles tubers and rhizomes. It is occasionally found damaging coconut seedlings. The paradichlorobenzene soil treatment, described above, can be used with success against this pest.

ACKNOWLEDGMENT

The notes on pests and diseases and their control, under general care of nursery, have been compiled from information kindly supplied by the Entomologist and Mycologist of the Department of Agriculture, Peradeniya, to whom my thanks are due.

COVER CROPS SUITABLE FOR COCONUT ESTATES*

THE following notes have been prepared in response to the demand for information on the planting of Cover Crops suitable for coconut estates.

The three species recommended below have proved to be the most suitable under local conditions :—

Calopogonium mucunoides.
Centrosema pubescens.
Pueraria javanica (*phascoloides*).

(1) CALOPOGONIUM MUCUNOIDES

A quick-growing plant, it thrives on a wide range of soils and forms a cover in six to eight months if sown under suitable weather conditions. Seeds are flattened and brown. *Calopogonium* dies back during drought and after seeding, but regenerates after the rains.

It is best sown as a mixture with *Centrosema.*

(2) CENTROSEMA PUBESCENS

Compared to *Calopogonium, Centrosema* makes slow growth in the early stages, but when properly established forms an excellent cover. It is very hardy and does not easily die back during drought. If die back occurs recovery is very rapid after rains. Seeds are flattened, brownish green with dark-green markings.

Centrosema may be considered the most suitable under general conditions.

(3) PUERARIA JAVANICA (PHASEOLOIDES)

In general appearance resembles *Calopogonium,* but the leaves are much larger and hairy. Roots profusely at the nodes. Seeds small, dark-brown and susceptible to insect attack, and sometimes shows poor germination.

Though it can be grown on a variety of soils, it is particularly useful for the heavier types of soils. Growth moderately rapid and forms a dense thick cover in one to one-and-half years. Shows a slight tendency to die back during drought, but recovers after a few showers.

Pueraria seeds are expensive, but it may be readily propagated from cuttings.

(4) MIXTURES

It is often an advantage to sow a mixture of a quick-growing cover crop, such as *Calopogonium,* which dies back during a drought or after seeding and a slow-growing, hardy, perennial species such as *Centrosema. Calopogonium* germinates quickly and smothers the weeds, while the slow-growing *Centrosema* gradually establishes itself. Once the *Calopogonium* dies back the *Centrosema* takes its place and forms a uniform complete cover.

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*By M. L. M. Salgado, Soil Chemist, Coconut Research Scheme (Leaflet No. 3).

(5) PLANTING COVER CROPS

(*a*) *Seed Bed.*—The importance of a seed bed free from weeds must be stressed if a cover is to be quickly and successfully established. The land should be first ploughed and disc-harrowed across the ploughed furrows, and all weeds collected and removed. A final harrowing with a chain harrow produces an ideal surface for sowing seed, and also helps in the complete removal of weeds. If a chain harrow is not available, the disc-harrowed surface should be levelled with mamoty-forks or hand rakes.

Where covers are planted for the first time, and particularly in the case of poor sandy soils, it is recommended that a start be given by the application of a small amount of cattle manure or a small dose of artificial manure. A suitable mixture would be Sulphate of Ammonia 1 lb., Superphosphate 1 lb. and Muriate of Potash 1 lb. per square.

(*b*) *Planting Covers on Husk Trenches.*—Covers may be easily established by planting on trenches in which coconut husks have been buried and covered with soil. This method also favours the decay of the husks.

It is needless to mention that planting should always be done during the rainy season, preferably at the beginning of rains.

(*c*) *Seed Rates.*—A seed rate of 15 to 30 lb. per acre may be considered sufficient under general conditions, the seed being broadcast. If seed is plentiful and comparatively cheap a higher seed rate may be used, especially on poor sandy soils.

If planted in rows, two feet apart, a seed rate of about 8 lb. per acre may be used. In this case it is possible to weed between rows till the cover establishes itself.

In planting a mixture of *Centrosema* and *Calopogonium*, 12 lb. *Centrosema* and 8 lb. *Calopogonium* would form a suitable mixture.

Centrosema seeds which have a hard seed coat will germinate more readily if soaked overnight in water. Seeds so treated should not be allowed to dry before sowing, and should be planted in rainy weather.

After sowing, the seed should be covered by lightly forking in with mamoty-forks, hand rakes or by a chain harrow. It is also a good practice to cover the planted areas with coconut fronds.

(*d*) *Pueraria.*—Seeds of *Pueraria* are somewhat expensive, being about a rupee a pound, compared with *Calopogonium* which costs about 30 cents and *Centrosema* about 20 cents a pound. Further, *Pueraria* seed often show poor germination. Economy in seed rates in planting *Pueraria* can be effected in two ways :—

(*a*). The seeds may be germinated in a nursery on coconut husk containing a mixture of soil and dung. The seedlings may be subsequently planted along with the husks at distances of 3×3 feet.

(*b*). *Pueraria* may be easily propagated from cuttings which can be lifted with numerous adventitious roots. These should be planted in wet weather.

(6) TREATMENT OF COVER CROPS

Once established the cover should not be allowed to grow rank and left permanently untreated. Opinion differs as to the best method of treating the cover, but the following methods can be tentatively recommended :—

(*a*). Harrowing once a year and even twice a year when the cover is thick.

(*b*). After harrowing the cover first, it may be ploughed in once in two years. Ploughing in a thick cover without a preliminary harrowing is very difficult and is not to be recommended.

(*c*). The cover may be dug over with mamoties once in two years. Digging will be facilitated if the cover is first harrowed. This treatment has, however, been found to be somewhat severe on *Pueraria*.

(*d*). The cover may be envelope-forked.

It must be stressed that the treatment of cover crops should only be carried out during the rains, so that the cover would regenerate itself from the buried cuttings or self-sown seed.

It is also recommended that alternate rows and not the entire field should be treated. In case adverse weather conditions follow the treatments and the cover fails to regenerate in the treated rows, the untreated portions would grow over into the neighbouring rows, and the land would not be without a cover. *Pueraria* is often slow to recover, and such a treatment would be advantageous in the case of this cover. A further advantage of this method of treatment is to check erosion on hilly land if heavy rains follow. In this case the rows treated should be in contour strips.

(7) COVER CROPS ON YOUNG PLANTATIONS

Where the cover crops are grown on young plantations it is essential that an area round the young palms up to a distance of six feet should be kept clean weeded. Otherwise the creepers tend to climb up the young palms and check their growth.

(8) COVER CROPS AS FODDER

Cover crops may be utilised as fodder by grazing cattle lightly. Especially during dry weather heavy grazing should be avoided or else the covers may fail to recover. *Centrosema* is particularly relished by cattle. *Calopogonium* seems to be less favoured, but buffaloes are indifferent and eat all these varieties with a preference for *Centrosema*.

MOTTLE-LEAF OF CITRUS—PRELIMINARY NOTE ON CORRECTION IN SOUTH AUSTRALIA WITH ZINC SPRAYS*

CITRUS mottle-leaf or foliocellosis has been noted in various citrus-growing districts throughout South Australia, the disorder occurring under varying soil, climatic and cultural conditions. Specific occurrences of mottle-leaf have been under observation in such dissimilar districts as Berri, Waikerie, Mypolonga and Beetaloo Valley, and although a variation in intensity of the trouble has been noted, the general symptoms have been similar in each area.

As has been the experience in the United States, there appears to be in South Australia a number of indirect casual or contributory factors associated with the mottling; very heavy infestation of tree roots with the Citrus Nematode (*Tylenchulus semipenetrans*) was found to be associated with cases of mottle-leaf occurring at Berri, Waikerie and Beetaloo Valley, thus confirming the observations of Thomas, in California. Affected trees at Beetaloo Valley, in addition to being heavily infested with citrus nematode, were located in soil containing injurious salts (notably sodium chloride) at concentrations generally considered inimical to maintenance of thriftiness.

Neither heavy nematode infestation nor excessive soil salinity were obviously associated with the incidence of mottle-leaf at Mypolonga.

At Beetaloo Valley, steps were first taken to correct the position in regard to soil salinity, the grower being advised to vary his irrigation practice in such manner as to aim at downward leaching of salt, and to safeguard against further undue saline accumulation in the surface soil.

In other centres where citrus nematode was the chief associated factor, the position initially appeared to be very difficult ; owing to the nature of the citrus nematode, no direct measures against this pest could be suggested. There is abundant evidence that on suitable soils, and where good cultural practices are employed, citrus trees may be maintained in good health, despite the presence of citrus nematode on their roots. That is to say, combat of citrus nematode must consist in ensuring that soil and cultural factors are as favourable as possible.

Recent investigations in America have indicated that mottle-leaf may often be related to deficiency of zinc, whatever indirect contributory or secondary

*By A. G. Strickland, M. Agr. Sc., Chief Horticulturist in *The Journal of the Department of Agriculture of South Australia*, Vol. XL, No. 7, February, 1937

factors may be operating ; or at least, that the mottle-leaf condition may, in many cases, be rectified by application of zinc compounds. Various factors frequently associated with mottle-leaf—such as citrus nematode infestation, soil salinity, lack of soil humus, &c.—may be partially contributory. The exact relations of these factors still remain to be determined, but as treatments with zinc has been so widely successful in other countries, experiments have been conducted with zinc compounds in several South Australian districts.

First attempts to supply zinc to citrus trees suffering from mottle-leaf consisted of direct applications to the soil of zinc sulphate ; although this method was usually effective, it was also dangerous and frequently resulted in injury to treated trees.

When citrus trees are sprayed with zinc compounds, the leaves are able to take up appreciable quantities of zinc, and there is little or no danger of tree injury. Experimental work in South Australia has been confined to the application of zinc-containing sprays.

SYMPTOMS OF MOTTLE LEAF

The leaves show irregular yellow chlorotic areas between the main lateral veins, the part surrounding the mid-rib and lateral veins usually remaining green. The result is an irregular mottling, and where trees are but slightly affected, little or no effect on tree health or cropping may be noted.

In severe cases, however, leaves on new growth are frequently small, and there develops considerable die back of young twigs, the tree becoming stunted, unthrifty and unproductive.

EXPERIMENTS IN SOUTH AUSTRALIA

The chief experiments on mottle-leaf control have been carried out at Berri, but check plots have been also sprayed at Waikerie, Mypolonga and Beetaloo Valley.

TRIALS WITH ZINC SPRAYS AT BERRI

The materials concerned in these trials consisted of 60 late Valencia orange trees on the property of Mr. B. H. Jungfer. The trees were seven years old, and the cultural treatment which had been applied to them subsequent to planting was such that they were expected to thrive ; the soil type on which they were planted was Winkie Sand according to the Council for Scientific and Industrial Research Soil Survey classification, there was no evidence of high water table or soil salinity, and a sound cultural programme had been practised. Nevertheless, each of the 60 trees—disposed in two rows each of 30 trees—was showing severe mottle-leaf. Orange trees of mature age immediately adjacent were generally thrifty and productive, although occasional instances of mild mottle-leaf were also noted in these mature trees.

During March, 1936, individual trees were treated in rotation as follows :—

1. Sprayed with zinc sulphate 10 lb., hydrated lime 5 lb., skim milk 3 galls. per 100 galls. of water.

2. Sprayed with zinc sulphate 5 lb., hydrated lime $2\frac{1}{2}$ lb., skim milk 3 galls. per 100 galls. of water.

3. Not sprayed.

At this time, root specimens were taken from the trees under test, and examination of these specimens showed that the trees were heavily infested with citrus root nematode (*Tylenchulus semipenetrans*).

RESULTS

A slight improvement in the appearance of sprayed trees was noted in June, 1936, and this improvement became more marked as the season progressed. In spring, the difference was readily visible, trees sprayed with both levels of zinc showing a more thrifty appearance, and throwing out healthy growth. The improvement was consistent, all sprayed trees exhibiting better health, and all unsprayed trees remaining severely mottled and non-thrifty. The sprayed trees carried heavier bloom, and it was also noted that the restricted blooming of unsprayed trees was irregular and retarded.

A second series of sprays was applied early in October, the half- strength zinc-lime mixture being substituted on this occasion by a spray of zinc oxide—3 lb. per 100 gallons.

An interesting feature of this trial is the fact that despite heavy nematode infestation, and the extremely unhealthy condition of fibrous roots—apparently sufficient to account largely for the non-thrifty condition of the trees—zinc treatment has resulted in remarkable improvement.

This suggests that zinc sprays may be stimulative, rendering the trees more vigorous, and better able to grow normally in association with the root nematode.

Clark Powell and Mathews have recorded in South Africa, that mottle-leaf affected trees, five months after application of zinc sulphate sprays, showed marked development of new fibrous roots ; unsprayed trees did not show this tendency to develop new feeding rootlets.

This apparent effect of zinc treatment in stimulating root development is obviously of importance when trees are infested with root nematode.

TRIALS IN OTHER DISTRICTS

Since the initiation of zinc spraying trials at Berri, similar trials have been carried out at Waikerie, Mypolonga and Beetaloo Valley. In each of these centres, spray treatment have been applied more recently than at Berri, and it is yet early to expect responses as marked as those noted at the latter centre. However, in every instance, visible improvement in tree health, and some disappearance of mottle-leaf symptoms have already been observed.

At Waikerie, trees affected with mottle-leaf have been subjected to zinc treatment on two properties, and in each instance improvement has occurred. In the Mypolonga area, Washington navel orange trees and lemon trees have

been subjected to experiment on neighbouring properties ; sprays of zinc sulphate-lime mixture 10 : 5 : 100, and zinc oxide—3 lb. per 100 galls. were applied in August and again in October to certain sections. Skim milk was used as a spreader and untreated plots were included.

Examination in January, 1937, disclosed improvement in all treated trees, the lemon trees showing a more marked response than the orange trees.

At Beetaloo Valley, an area of orange trees on the property of Mr. J. Halse has been badly affected with mottle-leaf for a considerable period. Investigation in 1935 showed that excessive soil salinity and heavy infestation of the roots with citrus nematode were both associated with the condition of the trees and, in so far as facilities permitted, irrigation technique was amended with a view to correcting the position in regard to soil salinity. Until recently, however, the amendment of irrigation technique of itself had not resulted in appreciable improvement of tree health.

In July, 1936, representative plots on this area were sprayed with zinc sulphate-lime mixture 10 : 5 : 100 and with zinc oxide—3 lb. per 100 gallons. The plots were examined in December, 1936, by District Adviser J. B. Harris, who state that whereas untreated trees have made no apparent improvement in health, all trees which have received zinc sprays are practically free from mottle-leaf and making healthy growth.

The application of zinc sprays to mottle-leaf-affected citrus trees in several districts has led to marked improvement in tree health, and the disappearance of mottle-leaf symptoms. The value of zinc applications under widely varying district conditions has been demonstrated but the exact manner in which the mineral achieves the response is still somewhat obscure.

Extensive research work in overseas countries is now throwing light on many previously obscure features of mottle-leaf, and micro-chemical analysis and cytological investigations are both important in the study of fundamentals. In the field, however, there is scope for considerable work in regard to the determination of conditions under which zinc may be expected to be of value, the optimum season for zinc spray treatment, the frequency at which zinc sprays should be applied, and the possibilities of combining zinc compounds with other routine sprays or dusts.

Nevertheless, the results achieved have been so outstanding that it is considered desirable to bring the known facts before growers in this preliminary report.

RECOMMENDATIONS

At this juncture, it is obviously impossible to issue a general recommendation, but in view of the success achieved in preliminary experiments, it is suggested that growers should conduct on their own behalf trial spraying of trees affected with mottle-leaf.

For such trials, a spray composed of 3 lb. of zinc oxide per 100 galls. of water is recommended ; a spreader such as lime-casein or skim milk (3 galls. per 100 galls.) may be employed. The cost of spray material is not high, a suitable grade of zinc oxide being available at from 6*d*. per lb. Although this spray may be applied with reasonable safety at any time of the year, it is undesirable to carry out extensive spraying within a short period of harvest owing to possible difficulty in removing spray residue.

Generally, better responses have been obtained when zinc sprays have been applied just prior to a growth period, and overseas experience has indicated that the beneficial effects of zinc treatment may be expected to persist for a period of approximately two years.

It is not anticipated that zinc treatment will correct unthriftiness where trees are grossly affected by seepage, excessive salt accumulations, poor cultural treatment, or other adverse environmental conditions, but there is definite promise that many cases of typical mottle-leaf may be successfully treated.

CITRUS CULTURE IN QUEENSLAND*

CULTIVATION

DIFFERENCES of opinion which occur concerning the best method of cultivation for citrus fruits may be partly explained by the fact that soils vary in character and in the amount of moisture and fertility they contain. The systems adopted must, therefore, necessarily vary somewhat in order to meet the requirements of the particular soils.

In Queensland cultivation is an essential orchard operation, and is beneficial in the following ways :—

It improves the physical condition of the soil by making it finer and increasing its depth, thus presenting greater feeding areas to the roots.

The effects of extremes of temperature are reduced, as air is permitted to penetrate to the roots.

In cultivated soils decomposition and nitrification go on more readily, and if materials are present from which nitrogen can be set free, its liberation takes place more rapidly than if the soil is uncultivated.

It increases the water-holding capacity of the soil and conserves moisture.

On the other hand, the fact must not be lost sight of that cultivation may cause unjurious effects. Unless care is used, plough-sole may result, and greatly hinder proper water penetration. Also continuous cultivation causes the destruction of the organic contents of the soil and a decrease in the bacterial life. If cultivation is continued throughout the whole season year by year, such soil will soon become depleted of its natural fertility and the trees will show the effects by their unhealthy condition.

The loss of soil organic matter is a major problem in tropical agriculture in all parts of the world, and is particularly severe in many parts of our citrus plantations. Therefore, when considering cultivation programmes, the improvement of the humus content of the soils must be of primary importance. Where young trees are concerned, deep cultivation is advisable in order that large quantities of organic matter, such as manure and green manure crops, can be deeply incorporated with the soil. There should be no danger of injury to the roots of young trees in cultivation to a depth of 10 or 12 inches. However, as the trees become older their rooting systems extend widely in all directions, and, therefore, as deep cultivation will be liable to cut too many feeding roots, shallower cultivation will probably be more satisfactory.

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*By R. L. Prest, Instructor in Fruit Culture, in *Queensland Agricultural Journal*, Vol. XLVII, Part II, 1st February, 1937

In order to prevent the formation of plough-sole, cultivation at varying depths is frequently practised. However, plough-sole will form in many soils even though the depth and direction of the ploughing is varied, and in such cases subsoiling to a depth of from 18 to 20 inches may have to be resorted to in order to break up any hard pan that may be present. Such work should only be done when the soil is dry, and the subsoiler should be run only in the middle of the rows, otherwise severe root-cutting will result. Subsoiling should not be carried out either just prior to or just following the blossoming period.

GREEN MANURING

Humus, the product of the decay of organic substances, is one of the most important ingredients in any fertile soil, and, generally speaking, is present in only adequate amounts in most of our citrus soils. Except in alluvial lands periodically improved in fertility by floodings, the orchardist must consider the maintenance or improvement of the soil fertility if he wishes to harvest good crops. In the absence of bulky organic farmyard manure, the maintenance and improvement of the soil fertility may be carried out by the growing and turning-under of green manure crops. Not only do such crops build up the physical condition of the soil, but their presence reduces soil losses by erosion during periods of heavy rainfall. When green manuring, particularly in the coastal districts, the general practice has been to utilise the summer rainfall, planting such crops as black cowpeas, Poona peas and Crotalaria during November and December and turning them under about the following March. Winter green manuring with crops such as beerseem (Egyptian clover) vetches, field peas, tick beans, lupins, rape and mustard could in many instances be practised with advantage particularly in young orchards, and in orchards on the lighter, sandy soils, and where irrigation is practised. For winter crops planting should take place during March and April, and turning-under in July. Citrus trees up to four or five years of age occupy a relatively small proportion of the total area on which they are planted, and their roots do not extend so far from the trunk nor take the amount of space occupied by those of old-established trees. Thus during the early years of a citrus orchard an excellent opportunity is afforded for building up a reserve of vegetable matter in the soil. At this stage cultivation, even early in the season, may be confined to the immediate vicinity of the trees and by far the greater amount of space down the centres of the tree rows occupied by growing and turning-under summer and winter green manure crops.

FERTILISING

In reasonably fertile lands the addition of artificial fertilizer to the soil either before or at the time of planting is unnecessary, but in land that has been previously cropped or which would not be classed as fertile, assistance to the growing plants in this direction is required. No matter what fertilizer is applied it should be incorporated with the soil so that the young roots in traversing the soil may come in contact with it. However, it should not be brought into direct contact with existing roots at the time of planting.

As the trees develop, the quantity of fertilizer required for each will correspondingly increase, and when fully developed and evenly continued, regular supply is necessary. As crops are produced, so the natural fertility of the soil is being depleted, and where it has not been restored by the application of such fertilizer as is available, the effect is shown by impaired vigour of the trees and poorer quantity and quality of the fruit produced. General observations made from field trials indicate that nitrogen is one of the main constituents required to maintain healthy and vigorous citrus trees, but at the same time phosphoric acid and potash have their place. At least 6 cwt. of ammonia to the acre, with 3 cwt. of phosphoric acid and 2 cwt. of sulphate of potash, would be a basis for a fertilizing programme for mature bearing trees. The nitrogen is best supplied so as to be available during the spring, as such practice tends to increase the crop and improve the quality. Whether or not an autumn application will be necessary will depend upon the vigour of the trees, as it must be remembered that the promotion of too much vigorous growth at this period is detrimental to the production of high-grade fruit. However, it will be found that a light dressing of nitrogen with rather increased quantities of phosphoric acid and potash, will assist in maturing autumn growth and future fruiting wood, and will also benefit the crop.

The value of lime in citrus culture may be viewed from two angles—its influence on the trees, and its effect on the soil. The presence of lime appears to aid the vigour of the trees, and improve the delicacy of the fruit, while in the soil it corrects acidity, improves the physical condition, aids the decomposition of organic matter, stimulates bacterial activity, and generally assists in improving soil fertility. Lime should be applied in the autumn in the form of agricultural lime, as its action in the form of powdered quicklime or air-slaked lime is too rapid and powerful.

HARVESTING

The subject of careful handling of fruit has been so frequently stressed that further details here seem superfluous. The chief points to be remembered are that the fruit should be cut from the tree as close to its base as possible (an orange clipper specially made for the purpose is available at a nominal cost), and that it should be treated as fragile during the first and all subsequent handlings, and carefully stored and graded before packing. Various grade sizers are obtainable and selection can be made according to the output of the orchard. Wrapping the choicest fruit when packing enhances its appearance and increases its value, besides having other advantages, such as prevention of the spread of storage and transit of diseases. Fruit should be gathered only under the driest possible atmospheric conditions, and never as is often done, during showery weather. It should be sweated for at least seven days, and then carefully graded for blemishes and disease, sized and packed.

COLOURING

No fruit should be gathered from the trees until it has reached maturity. The maturity standards for citrus fruits are as follows :—

In the case of oranges, grape fruit and mandarins the weight of the hand-pressed juice must not be less than 30 per centum of the total weight of the fruit.

With regard to the juice, in the case of navel oranges and mandarins, 10 cubic centimetres of the juice shall be neutralised by not more than 26 cubic centimetres of deci-normal (N/10) alkali ; and in the case of oranges (other than navel oranges and mandarins) 10 cubic centimetres of the juice must be neutralised by not more than 30 cubic centimetres of deci-normal (N/10) alkali.

As citrus fruits are only sold to their best advantage when they are mature, full-flavoured, and showing an unblemished skin with its normal ripe colour, assistance by colouring to such fruit as lack normal colour but possess the other qualities will enhance its market value. Citriculturists who have had experience in various citrus-growing localities will agree that certain varieties of oranges and mandarins growing in the cooler regions have ample colour long before they attain sufficient sugar to make them desirable for eating purposes, while those produced in warmer climes are sweet and luscious for sometime prior to their attaining a normal ripe colour.

The colouring or forced curing, a practice known in California as "sweating," was formerly done by gaseous products generated from kerosene stoves. In 1924 Denny found that ethylene gas in small quantites was capable of producing the same results. He also found, however, that a very high percentage of gas (for example 80 per cent.) delayed colouring. Colouring was also delayed by temperatures as high as 92 degrees Fahr. and as low as 45 degrees Fahr. A temperature of between 60 and 70 degrees Fahr. with a humidity of from 70 to 75 per cent. was found to be satisfactory.

Ethylene gas can be obtained in metal cylinders under a high pressure, with regulator valves attached to the cylinders. When released from the regulator valve the gas is conveyed by tubing into the colouring chamber. The quantity of gas passing into the room is recorded by the valve on the cylinder, so that the correct charge according to the size of the chamber can be readily determined.

It has been found that a very small quantity of acetylene gas (1 part in 2,500 to 1 part in 1,875) satisfactorily colours mature citrus fruits. In order to determine the dosage required, the air space remaining after the chamber has been loaded must be known. One ounce of carbide generates sufficient gas for every 75 cubic feet of air space. For all practical purposes it is sufficient to allow $1\frac{1}{4}$ cubic feet displacement for each bushel case of fruit. For example the following table illustrates the dosages required for a chamber of 200 cubic feet capacity with a varying number of cases :—

No. of bushel cases	*Air space*	*Dosage*
40	.. 150 cu. ft.	.. 2 oz. Carbide
20	.. 175 cu. ft.	.. $2\frac{1}{3}$ oz. Carbide
10	.. $187\frac{1}{2}$ cu. ft.	.. $2\frac{1}{2}$ oz. Carbide

In order to satisfactorily colour citrus fruits, they must have reached maturity, as if too green or immature they will not develop a normal ripe colour, but will shrivel and become dull and dirty in appearance.

All fruits to be coloured require to be treated with special care in handling. Bruises will show up as greenish areas ; oil liberated from the rind may cause spotting; while if the residues of oil or Bordeaux sprays remain on the fruit, it will be found to come from the colouring room spotted and unsightly.

An ordinary room lined with timber, provided it is airtight, can be used for colouring citrus fruits. A convenient and economical size is one to hold from 40 to 50 bushel cases ; allowing 5 cubic feet of air space to each bushel case, the chamber would require to be from 200 to 250 cubic feet in capacity. Even where large numbers of cases are to be treated, it will be found more satisfactory to build two medium-sized chambers than one large chamber.

For oranges, lemons and mandarins an average temperature in the chamber between 65 and 75 degrees Fahr. will prove satisfactory. If the temperature falls below 65 degrees Fahr. the colouring process will be retarded. On the other hand, high normal temperatures are not likely to affect the fruit, no ill-effects having been shown by temperatures up to 89 degrees. However, the humidity will require to be adjusted ; in the case of a very dry atmosphere an open container of water may be introduced to moisten the air and prevent withering of the fruit ; while when the humidity is high and likely to cause softening of the fruit, it may be reduced by placing sand, caustic soda, or quicklime on the floor of the chamber.

The fruit should be graded for colour and placed loosely in open cases having plenty of ventilation. Dunnage should be used in stacking so that a free circulation of air round each case is permitted.

The required quantity of carbide should be placed in a suitable container, and a second vessel containing water arranged in such a manner as to permit the water to drip slowly on to the carbide, thus generating the acetylene gas. This apparatus may be fitted either inside or outside the chamber ; if the latter, of course,the gas will have to be led inside the chamber by means of suitable piping.

After closing the chamber and making sure that it is airtight, it should be charged and allowed to remain closed for four hours. It should then be opened up and thoroughly aired for at least two hours, after which it may be charged again, and the performance repeated as often as is necessary. Between nine and fifteen charges should be sufficient to give mature citrus fruits their normal colour.

PICKING AND CURING OF LEMONS

Lemons carefully handled and gathered at the right stage of maturity may be successfully cured and stored on the orchard for several months without deteriorating, but rather with improvement to their appearance and carrying qualities.

All fruits should be clipped, not pulled, from the trees just as they are turning colour. The fruit should be of normal size, and the dark green colour just turning to a paler shade, generally termed "silvering." In order to avoid injuring or bruising, and thereby leaving the fruit open to attack of moulds, it is important to remember that it must at all times be handled with the very greatest of care.

After picking the fruit should be placed in shallow trays and allowed to remain for several days to sweat off excess moisture. When storing for any length of time, dipping for a period of one or two minutes in a bluestone solution, strength 1 in 500, is recommended. The fruit, after being thoroughly dried, is packed in bushel cases and stacked in a storing chamber in such a manner as to permit a ready circulation of air.

Such chamber should be so constructed as to lend itself to control of the relative humidity. A low relative humidity results in the shrinkage of the lemons, with a consequent loss of weight and an inferior colour in the fruit, accompanied by shrivelling, as well as the browning and dropping of the buttons of lemons held in storage for any period. These conditions are mostly apparent during late spring, a period of comparatively high day-time temperatures and low relative humidity. Satisfactory conditions may be obtained by controlling the humidity at from 85 to 90 per cent. For controlling the humidity a humidifier may be cheaply constructed by hanging a series of absorbent cloths from a frame, above which is fixed a small perforated iron water-pipe permitting water to drip when required, and circulating the air in the chamber by means of a small fan. Under such conditions lemons may be stored for several months.

Another method used in storing lemon is, after sweating, to pack the fruit loosely, either wrapped or unwrapped, in cases lined with paper, and stack in a cool dry shed in blocks of from 50 to 60 cases covered with canvas sheets or tents. Low open water containers may be introduced when necessary, always taking care to avoid as far as is possible extreme variations in temperature and humidity. The fruit should be examined at intervals of ten days, and any showing signs of decay removed.

Again the fruit may be stored either wrapped or unwrapped, loosely packed in cases lined with paper and using straw as a filler. The bottom of the case is covered with a layer of straw, a layer of lemons placed thereon, the spaces between the fruits filled with straw, and the lemons covered with a layer of straw, and so on, using alternate layers of fruit and straw until the case is filled. The cases should be stacked, covered, and periodically examined as described in the previous method.

HOW TO MAKE "HUMUS"*

HUMUS can easily be made on the farm from waste substances which are generally burnt or buried. Leaves, grass, weeds, etc., must be collected and thrown into a kraal where cattle or other animals sleep. The animals by tramping on this vegetable refuse, mix it thoroughly with their dung and urine, in consequence of which fermentation and decomposition soon set in.

THE PIT METHOD

The vegetable refuse must be thrown into the kraal daily in such quantities that it can be thoroughly tramped and thus mixed by the animals. The material in the kraal must also be kept moist. After thirty or forty days this mixture is made into a heap, after which it is removed to a pit as soon as possible. The process of converting animal and vegetable refuse into valuable humus is then started anew by conveying fresh quantities of weeds, leaves, grass, etc., to the kraal.

The pit for the refuse consists of a hole about two feet deep made in the ground by means of a scraper, pick and spade. The pit may be of any length and width, and it is well to make it with sloping ends so that a wagon or Scotch cart can pass right through in off-loading the refuse, whereby labour is saved and the refuse pressed down at the same time. The pit should also have slightly sloping sides, and since water is essential for the making of humus, all pits and kraals should be made as near to water as possible.

If the refuse appears to be fairly dry, when the pit has been filled, it should be moistened by means of a hose or bucket or by irrigation. In the latter case, extreme care must be taken not to fill the pit with water and thus push up the refuse into the air, since this will prevent fermentation from taking place. Corrugated iron or old bags may be used to distribute the water evenly over the refuse, which is then covered with a layer of earth two or three inches deep.

Twelve days later the pit has to be moistened again, and eight days later the refuse should be forked-over and moistened again if it appears to be dry. After twelve days the process of moistening and forking-over is repeated. If the refuse is then well rotted it should be made up into a heap outside the pit and removed to the lands after the lapse of a further eight days, but if, after the second forking-over, the refuse is not sufficiently rotted, it should be left in the pit for a further twelve days and moistened again.

*By C. J. J. van Rensburg, Officer-in-Charge, Rietondale Pasture-Research Station in *Farming in South Africa*, Vol. XII, No. 130, January, 1937

THE KRAAL METHOD

Humus can also be prepared without the use of pits, in which case a heap is made in the kraal thirty days after the waste substances have been deposited there. This heap should also be moistened while it is being made and twelve days later again, when it is being forked-over. In all, the heap is forked-over four times before it is ready for use. A plough may be used to turn over the animal and vegetable refuse in the kraal and a scraper can be used to work it into a heap. Water is a very important factor, since the heap must be kept moist, and on no account should one neglect to fork it over the requisite number of times.

Bedding from stables may be used for the making of humus, but, if possible, it should be taken to the kraal first. Stables generally have cement or stone floors and thus the liquid portion of the manure, which is very valuable, is often lost, whereas it could easily be run into a bucket or cement hole and mixed with substances in the kraal.

VELD GRASS

The veld grass which is burnt annually could be converted into thousands of tons of valuable humus. If one considers how much humus is required by our soils and how much grass is destroyed, one can come to but one conclusion, namely, that veld fires are the curse of our country. Not only grass but also other valuable plants are destroyed by fire, while the small quantity of humus which the plants themselves impart to the soil is lost and the earth becomes hard and barren. No wonder that our country is fast drying up, since the soil is daily robbed of its moisture and humus, and nothing is done by us to replace the loss.

During the winter months, when there is less work to be done on the farms, the veld grass should be cut, gathered and stacked near the kraal. It can then be used as bedding during the rainy season and afterwards converted into valuable humus.

If old veld grass is difficult to cut with a mower, a hay rake should first be used and all the old loose grass made into a heap. The remaining grass can then be easily cut with the mower. If this method is followed, excellent humus will be obtained.

WHEAT STRAW

In view of the large quantities of wheat straw that are still being burnt daily in the Transvaal and the Cape Province, *e.g.*, at Rustenburg, Brits, Rust-der-Winter, Caledon, Bredasdorp and elsewhere, it would appear that the value of wheat straw is not yet realized.

Wheat straw can easily be converted into humus. At Rust-der-Winter the following methods were used with excellent results during the past six months :

(1) The method followed at Rietondale of leaving the wheat straw in the kraal for the prescribed period and treating it according to the method described previously, and then removing it to pits. (Fourteen trek-oxen slept in the kraal for six months and forty tons of humus were made).

(2) Wheat straw and old kraal manure in the proportion of four to one were taken to the pits and there treated in the same manner as at Rietondale. In both cases the humus was excellent, but the first method seems to be the better, since old kraal manure is very scarce.

At Rietondale about 900 tons of humus were produced during 1934, 1935 and 1936, and at Drylands farm twenty head of cattle were responsible for eighty tons of humus in one year. In the latter case no humus pits were used.

THE VALUE OF CATTLE KRAALS

Humus to the value of £7 to £10 can be obtained annually from every animal, if the correct methods are used. This, of course, means that the cattle must have kraals in which to sleep or take shelter during cold weather : such kraals can be erected quite cheaply, and, if proper bedding and salt are provided, the cattle will soon leave their own sleeping places for these more comfortable quarters. They will then repay the farmer a hundred fold by producing sufficient valuable humus for his lands.

THE APPLICATION OF THE HUMUS

When the humus has been taken to the lands, it should be spread over the soil and ploughed or harrowed in at once and should not be exposed to the sun and wind for any length of time.

It is difficult to lay down hard and fast rules as to the quantity of humus to be used, since so much depends upon circumstances, *e.g.*, the nature of the soil, the purpose for which the land is to be used, etc. but the writer would recommend the use of two to six tons per acre once or twice a year rather than twenty tons once in three years.

BRIEF SUMMARY OF METHODS

The Pit Method.—Leaves, grass, weeds, etc., collected and thrown into a cattle kraal daily ; after thirty or forty days, work into a heap and remove to a pit about two feet deep with sloping ends and sides; when the pit is full, moisten ; cover with layer of earth two to three inches deep ; moisten again after twelve days ; fork-over after eight days and moisten if dry ; moisten again after twelve days ; fork-over eight days later ; if ready for use, make into a heap outside the pit and remove to lands eight days later ; if not ready for use, leave in the pit for another twelve days and moisten ; spread over soil and plough in at once.

The Kraal Method.—Leaves, grass, weeds, etc., collected and thrown into a cattle kraal daily ; after 30 days, work into a heap in kraal and moisten ; work over and moisten four times at intervals of twelve days.

NUTRITION AND HEALTH*

GOVERNMENTS have for many years provided all kinds of public services but it is only recently that they have been called upon to devise means for securing the community from hunger and from ill-health associated with inadequate dietary. It is strange that so little attention has officially been paid to this problem in the past but it must be remembered that the scientific study of nutrition only began in earnest during the last century. Thirty years ago it was still generally believed that the dietetic requirements of human beings were satisfied as long as they had enough to eat, although by that time Lavoisier's classical experiments on the functions of food in the human body made at the end of the eighteenth century, and Liebig's nutritional studies begun in 1840 were already known. Liebig's views, however, greatly differed from our own and between his days and the close of the nineteenth century much good work was done on nutritional problems, at first in Germany and later in the United States. Within the present century considerably more progress was made in the field of nutritional science, especially during the War when Governments had not only to feed large armies whose physique and morale had to be maintained but also had to ensure an adequate food supply for the civilian population. Still more recently the world economic crisis and unemployment have imposed further responsibilities on Government in the sphere of public assistance of which the most urgent has been the combating of malnutrition. In this connection the Health Organisation of the League of Nations has for some years now been engaged on the study of nutrition in relation to public health and as a result of its investigations the problem has attracted considerable public attention. Sir John Orr, for instance in a remarkable address to the British Association stated that in 1935 there were some twenty million people, who, largely owing to poverty did not enjoy a diet which according to the modern science of nutrition was completely adequate for health. In view of the glut of all kinds of foods in the world such a statement is rather disturbing and it is not surprising to find that a little later that year Mr. Bruce, during a debate which took place at the Assembly of the League of Nations spoke of the benefits which would come of 'a marriage of health and agriculture " in the belief that a practical treatment of one question might help to solve the other. At the conclusion of this debate the Assembly adopted a resolution urging all Governments to examine the practical means of securing better nutrition. Following upon this, a circular despatch from the Secretary of State was sent out early last year to every

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British dependency on the subject of nutrition, and it has been left to committees appointed locally to consider this problem in relation to public health and especially its bearing upon agricultural, veterinary, educational and general policy in the Colonial Empire.

According to our existing knowledge of nutrition the adequacy of a dietary depends on the presence of a number of factors one of the most important of which is the provision of ample protective foods, especially dairy produce, fresh vegetables and fruit. The absence of such foods from a man's dietary may render him an easy prey to infectious diseases or impair all his capacities and his efficiency for any form of activity : their absence, furthermore, has especially deleterious effects upon children and upon nursing and expectant mothers. In the more advanced tropical countries much important work on nutritional problems has been, and is being carried out. Measures for the control of beri-beri in Malaya were an early example in the dietetic field of the application of scientific knowledge to public health questions on a large scale. In Trinidad, Seagar's investigations at the College in 1930 on labour efficiency threw some light on the subject of the dietary of Trinidad labourers. In brief, he noted a low calorific value, an excess of carbohydrates and a deficiency of fats, proteins and vitamins and established that faulty diet was one of the important factors influencing the degree of labour efficiency. He also stressed the need for educative measures to persuade workers that a diet which appeared to satisfy them might yet be unbalanced and was consequently inadequate for the preservation of health. In 1935 a Committee was appointed to make a survey of the general dietary and constitutional conditions of East Indian labourers in the various centres of the Colony. This Committee found that the diet of the East Indian labourers was ill-balanced, consisting as it did almost exclusively of carbohydrates while food of animal origin was almost entirely absent. The diet was reported to be grossly deficient in the superior proteins and animal fats and in all the vitamins while the quanity of milk supplied to infants and young children was stated to be wholly inadequate. The causes of the deficient diet were declared to be a preference for carbohydrates and the neglect of other available foodstuffs necessary for proper nutrition due to customs and thrift. It was also found that the dietary led to certain recognised specific signs of deficiency diseases and the prevalence of a peculiar chest condition. It was suggested that the first step towards reform must be education since without such preparation remedial measures would prove neither beneficial nor economical. It will be evident from these investigations that there is considerable room for improvement in the dietary of labourers in this and most likely other parts of the West Indies.

The question arises as to how this improvement is to be brought about. Educative measures have already been stressed and in all probability nutrition campaigns will be organised where the help of public health and agricultural officials, practitioners of medicine, health nurses, school teachers and social

workers will be enlisted. Other most pressing problems will include the determination and recognition of nutritional needs, the assessment of, and the best methods of utilising, the resources available to meet such needs and the provision, where necessary, of additional resources to meet new food requirements. All these problems are already being studied by the Trinidad Nutrition Committee which has been requested, as many other Committees appointed throughout the Colonial Empire to furnish the Secretary of State with a comprehensive review of the problem of nutrition in the Colony. The reports submitted by the various Colonies will eventually be considered by a Committee of the Economic Advisory Council, recently appointed by the Prime Minister with the object of surveying the present state of knowledge in regard to nutrition in the Colonial Empire, and of advising from time to time on the means calculated to promote the discovery and application of knowledge in this field.

From the agricultural point of view, apart from putting practical measures into effect such as the provision of an adequate supply of fresh milk which is generally a crying need in the Tropics, and encouraging the production of local foodstuffs there should be plenty of scope for suggesting lines of research on certain problems on which as yet little is known. There is, for instance, still a great deal to be learnt on the dietetic values of tropical foodstuffs especially in relation to the possible effects on the composition of such foods which have been grown with different kinds of fertilisers. Some useful information might also be collected on the effect of storage on the dietetic values of foods and on whether toxic effects, if any, are produced as a result of the use of poisonous sprays.

Among backward peoples such as inhabit many parts of the African continent Sir John Orr states that "there is a world of nutrition work waiting to be done. Disease is as prevalent among tribal races as among civilized people, and there is clear evidence that not only would much ill-health disappear, but better physique would result if the native food were adequate in quantity and quality. An improved supply of native foodstuffs depends upon an improved native agriculture designed to increase the supply of animal and vegetable foodstuffs rich in good proteins, vitamins and mineral matter. To direct African agricultural policy along the lines of increased production and consumption of animal products would undoubtedly have far-reaching effects on the health of the native, which might not inconceivably influence the whole future development of the continent."

Whatever is done in regard to the improvement of nutrition in the Colonial Empire important changes in economic and agricultural policies are bound to take place. In particular, schemes will need to be devised for making supplies of protective foods available at prices within the reach of all classes without prejudicing the interests of producers. If necessary, also, the question of the re-orientation of agricultural production, with the view of satisfying the requirements of sound nutrition, will have seriously to be considered.

CORRESPONDENCE

VEGETATION AND RAINFALL IN JAFFNA

The Editor,
Tropical Agriculturist,
Peradeniya.

Jaffna,
11th April, 1937.

Sir,

It is well-known that in the Jaffna District the annual rainfall is practically confined to two months in the year, October and November, when the North-East Monsoon prevails. Last year (1936) the rainfall even during those two months has been below the average, there having been practically no flooding or run-off. During the other months there is generally a continuous drought with a few showers of rain at unequal intervals.

Jaffna is a flat country slightly above sea level with no hills. In other countries similarly situated there has been found to be a close relationship between vegetation and rainfall.

I quote below the opinions of some scientific writers on the question. Mr. James Rodway, F.L.S., in his work "*The Story of Forest and Stream*" says: "Experience goes to prove that springs are conserved in a well-wooded country, and that they dry up if a great clearance is made. It has also been stated that tall trees attract rain-clouds and electricity, and are therefore responsible for many a local thunderstorm. Such storms often occur at seasons when the regular rainfalls, due to the great air-currents, are absent, and when, therefore, they are doubly useful. In Guiana it is certain that thunderstorms are more common over the forest, than over the sea, and we almost invariably see the black clouds moving from the coast and getting darker and darker as they approach the line of bush . . . What is the result of denuding a land of its forests? Almost certainly barrenness! Rain may fall in the usual quantity, yet from the want of masses of vegetation it will do harm rather than good." The writer cites the cases of the Island of St. Helena, Mauritius, Madeira, Curacao, Cape de Verde Islands and Ascension Island in support of his views. He further states that "examples could be found of similar results from denudations not only in small islands but in large tracts of country in Greece, Italy, Spain, France and Palestine."

Another writer, Mr. G. F. Chambers, F.R.A.S., in his work "*The Story of the Weather*" says: "It is a well-established fact that forests and trees

increase the rainfall of a district and diminish evaporation from the soil ; in other words, tend to make the days cooler and the nights warmer. This is partly because changes of temperature take place slowly amongst trees, but rapidly in an open expanse of air ; and also because trees obstruct nocturnal radiation ; and when the locality is a hill-side or a slope with trees at the top, they obstruct the descent of currents of cold air."

In Jaffna, about two decades back, the rainfall was more distributed than at present. At that time Jaffna was much more wooded and provided with high-growing and leafy trees than at present. In recent years a considerable number of high-growing trees of various kinds have been felled for timber without any attempt to replace them.

Can it be that the persistent and almost continuous droughts, which prevail in Jaffna for several months in the year, may be attributed to the destruction of high-growing trees ? If it is so the State should follow a policy of replanting as was done in Mauritius. The writer whom I quoted above, Mr. James Rodway, says, referring to Mauritius :— " After a violent inundation in February, 1865, followed by a period of drought, fever of a low type set in. These serious results led to attempts at replanting, and after about a million trees had been restored, the rivers and streams began to attain their former dimensions."

I am, Sir,
Yours in Service,
C. Arulambalam.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirty-sixth meeting of the Board of Management held at Dartonfield Estate, Agalawatte, at 10·30 a.m. on Wednesday, 20th January, 1937.

Present.—Mr. E. Rodrigo, C.C.S. (in the chair), Messrs I. L. Cameron, L. M. M. Dias, L. B. de Mel, J.P., U.P.M., George E. de Silva, M.S.C., F. H. Griffith, M.S.C., R. C. Kannangara, M.S.C., J. C. Kelly, F. A. Obeyesekere, J. L. D. Peiris, C. A. Pereira, B. M. Selwyn, E. W. Whitelaw and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director, was also present by invitation.

Apologies for absence were received from Mr. C. H. Collins, C.C.S. and Col. T. G. Jayawardena, V.D.

1. MINUTES

Draft minutes of the thirty-fifth meeting which had been circulated to members were confirmed and signed by the Chairman.

2. APPLICATION FOR GRANT FROM THE DEPARTMENT OF INDUSTRIES

A further letter from the Minister for Labour, Industry & Commerce regarding the conditions on which a grant for the purchase of machinery would be recommended, was considered. It was decided to inform the Minister that the Board would be prepared to provide facilities for training approved students in the use of the machinery within the limitations of its staff but if further facilities are required, the necessary funds would have to be provided for maintaining an increased staff.

3. ACCOUNTS

(*a*) *Statements of Receipts and Payments of the Board and the London Advisory Committee* for the quarter ended 30th September, 1936, were adopted.

(*b*) *Dartonfield and Nivitigalakele accounts* for September, October and November, 1936, were tabled.

(*c*) *Supplementary Votes.*

The following supplementary votes were approved :

1936—Books and Periodicals	..	.. Rs. 100·00
Botanical Laboratory	..	.. Rs. 800·00
1937—Telephones	..	.. Rs. 125·00
Entertainment of Visitors		.. Rs. 300·00

(*d*) *Fixed Deposits.*

Renewal of the following deposits was reported :

1. Rs. 50,000·00 at the National Bank of India, Ltd., for one year at 2% interest.
2. Rs. 25,000·00 at the National Bank of India, Ltd., for one year at $1\frac{3}{4}$% interest.

4. STAFF

(*a*) *Leave for Botanist and Mycologist.*

Application from Mr. R. K. S. Murray for period of leave to be extended to October 4th, 1937 was approved.

(*b*) *Advisory work during the absence of Botanist and Mycologist.*

The Chairman reported that arrangements had been made for the Government Mycologist to deal with advisory work on mycological subjects during the absence of Mr. Murray. A basis of remuneration for these services was approved.

(*c*) *Report on visit to Malaya and Dutch East Indies.*

The Chairman stated that Mr. Murray's report on his tour had been submitted and would be circulated to members in time for consideration at the next meeting.

5. EXPERIMENTAL COMMITTEE

The following decisions were reached regarding recommendations of the Experimental Committee :—

(*a*) *Nivitigalakele Conductor.*

Decided to terminate the services of the present officer and advertise for a successor.

(*b*) *Compost Manure.*

Decided that an experiment on the use of compost should be carried out as soon as circumstances permit.

(*c*) *Buildings at Culloden.*

Decided that the question of demolition of the buildings should be postponed.

(*d*) *Supplementary Estate Votes.*

The following votes were approved :—

Repairs to bridge	Rs. 545·00
Erection of cattle shed ..	Rs. 600·00
Construction of tennis court	Rs. 472·00
Construction of cattle bridge	Rs. 65·00
Increased remuneration to the Dispenser at Rs. 5 per month	60·00

6. MANUFACTURE OF VULCANISED PRODUCTS AT DARTONFIELD

Consideration was given to the desirability of manufacturing vulcanised products at Dartonfield for sale, in addition to rubber tubing which is now being made.

It was considered that manufacture on a small scale forms a useful demonstration of the possibilities of local manufacture and should be extended to other articles so far as this can be done without undue interference with other branches of work. Publicity should be given to the work so that anyone interested can obtain the necessary information to take up manufacture on a commercial basis.

7. AMENDMENTS TO RUBBER RESEARCH ORDINANCE

The Chairman reported that the following amending Ordinances had been passed :—

No. 35 of 1935—making provision for the transfer of the lease of Nivitigalakele to the Rubber Research Board.

No. 3 of 1936—enabling the Rubber Research Board to hold patents.

8. LETTER FROM CRUDE RUBBER COMMITTEE OF AMERICAN CHEMICAL SOCIETY

A letter from the Crude Rubber Committee of the American Chemical Society requesting information regarding the methods of manufacture employed by small-holders in Ceylon and suggesting a scheme of standardisation of coagulants employed, was considered together with the Director's suggested reply thereto. It was agreed that the reply should be sent.

9. SULPHUR DUSTING MACHINES

It was decided to recommend to Government that the machines used for the sulphur dusting demonstration in 1936 should be sold.

COCONUT RESEARCH SCHEME

BOARD OF MANAGEMENT

Minutes of thirty-sixth meeting of the Board of Management held at Bandirippuwa Estate on Friday, February 26, 1937, at 10·30 a.m.

Present.—Mr. E. Rodrigo, C.C.S., Acting Director of Agriculture in the Chair. Messrs C. H. Collins, C.C.S., Treasury Representative, O. B. M. Cheyne, A. R. Ekanayake, D. D. Karunaratne, J.P., Wace de Niese, Dr. H. M. Peries and Mr. G. Panditteseker, J.P., U.P.M.

Dr. R. Child, Director of Research, acted as Secretary.

MINUTES

The minutes of the previous meeting held on December 10, 1936, which had been circulated to Board Members were confirmed.

BOARD OF MANAGEMENT

The Chairman reported that Mr. A. R. Ekanayake had been renominated by the Planters' Association of Ceylon to serve on the Board for a further three years from February 7, 1937.

STAFF

Soil Chemist's New Agreement.—It was unanimously agreed to offer Dr. M. L. M. Salgado a new agreement on the termination of his present contract on June 30, 1937. The Board asked Mr. Collins to advise on the terms of the Soil Chemist's new agreement at the next meeting.

Appointment of new Field Assistant.—The Board accepted the recommendation of the Director of Research that Mr. M. Nadarajah, formerly employed at the Experiment Station, Anuradhapura, be appointed to this post.

Suggested employment of an extra clerk.—The Chairman reported that the Director of Research had submitted a memorandum stating that he considered it desirable to provide extra clerical assistance at Bandirippuwa. It was decided that the memorandum should be circulated to all members of the Board for discussion at the next meeting.

ANNUAL REPORTS

Annual Report of the Board of Management, 1936.—This is the Report of the work of the Board, which has to be submitted annually to the State Council in terms of Section 8 (2) of Ordinance No. 29 of 1928. Copies had been sent to all members of the Board on January 26, 1937. The Board approved of the Report.

Report of the Auditor-General on the accounts of the Scheme for 1936. This had been circulated.

Supplementary Estimate to be tabled in State Council.—In connection with this Mr. Collins referred to para 9, in which the Auditor-General wrote as follows :

> " 9. As required by the provisions of Section 8 (i) of Ordinance No. 29 of 1928, the original estimates for the year have been tabled in the State Council but a statement of the supplementary provision made by the Board of Management during the year to cover the excesses under the different items has not been so tabled."

He thought that this should be done and a statement of all supplementary votes for the year included with the Estimates for the following year, when these were tabled in October of each year. The Board concurred.

FINANCE

The Statement of Receipts and Payments for the 4th Quarter, 1936 was approved by the Board.

BUILDINGS SUB-COMMITTEE

The minutes of the fourth meeting of this Sub-Committee had been circulated to all members of the Board.

New Building for Battery Room and Stores.—The Board decided to accept the recommendations of the Buildings Sub-Committee. It was resolved to insert advertisements in the local press calling for tenders for the erection of this building. After the closing date for acceptance of tenders, those received are to be reviewed by the Building Committee and recommendation made to the Board.

Proposed additions to Senior and Junior Staff Bungalows.—Following the Board's decision at the previous meeting, the Architect had met the Buildings Sub-Committee for a preliminary consultation and had visited the sites. His report is now awaited.

Periodical Inspection of Buildings.—The Buildings Sub-Committee had considered the question of periodical inspection of the buildings at Bandiripuwa. The Director of Research was authorised to communicate with the Director of Public Works to enquire whether an officer of his Department would be able, for an appropriate fee, to conduct such inspections at intervals as required by the Board.

JUNGLE SUB-COMMITTEE

The minutes of the second meeting of this Sub-Committe held on February 19, 1937, had been circulated to all members of the Board. In accordance with the Board's decision at its previous meeting an independent valuation of Ratmalagara had been obtained. The Sub-Committee had regarded this estimate as a fair and reasonable one and had made the recommendation to the Board that an offer should be made for the property.

The Board resolved accordingly that negotiations should be continued on the basis of the valuation report.

ESTATE

The Estate Progress Reports for December, 1936 and January, 1937, were approved by the Board.

PROGRAMME OF EXPERIMENTS

In accordance with the Chairman's statement at the previous meeting the Director of Research had circulated a statement of the major experiments in progress or contemplated. The Chairman said that as the statement had been circulated only a short while before the meeting, it would perhaps be better for discussion on it to be deferred. The Director of Research suggested that members might like to comment on the report by letter to him, and any such written comments would be very useful as a basis for a discussion at the next meeting.

The Board decided to postpone discussion on the programme of experiments until the next meeting, the subject to be placed early on the agenda of that meeting.

In connection with this subject the Chairman enquired whether it would not be useful if circulation papers on experimental matters could be confined each to one experiment or group of experiments, so that members could file together for easy references all papers connected with each experiment. For example, one file would relate to the Scheme's N. P. K. manurial experiment into which all papers and periodical reports on this subject would go, the file thus providing a continuous history of the experiment. Dr. Child, thought that, as far as major long-range experiments only were concerned, the procedure would be useful, and undertook to make a start with a file on the N. P. K. manurial experiment.

OTHER BUSINESS

Manurial Experiments on Estates.—Mr. Cheyne referred to the preliminary discussion on this matter at the previous meeting. He said that he found that the London Director of a particular company would not agree to the expenses on fertilizers used in a co-operative experiment being shared equally by the Scheme and the company. Their attitude was that, the information obtained being for the benefit of the general public, the scheme as a publicly subscribed institution, should defray the whole cost.

Dr. Child said that he had discussed the subject with one or two private proprietors and they, on the other hand, would be willing to meet the Scheme on a fifty-fifty basis. As mentioned in the programme it was hoped to commence two such experiments during 1937 and the Board would be kept informed of progress in this direction.

Mr. R. K. S. Murray's Visit to Malaya and Java.—The Chairman reported that Mr. Murray's notes on his visit to Malaya and Java were now available and would be circulated to the Board as soon as possible.

The meeting terminated at 11·30 a.m.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirty-seventh meeting of the Rubber Research Board held at the Grand Oriental Hotel, Colombo at 10 a.m. on Tuesday, the 16th March, 1937.

Present.—Mr. E. Rodrigo, C.C.S. (in the chair), Mr. C. H. Collins, C.C.S. (Acting Financial Secretary), Messrs I. L. Cameron, L. M. M. Dias, L. B. de Mel, J.P., U.P.M., F. H. Griffith, M.S.C., Col. T. G. Jayawardena, V.D., Messrs J. C. Kelly, F. A. Obeyesekera, J. L. D. Peiris, C. A. Pereira, B. M. Selwyn, Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director, was also present by invitation.

Apologies for absence were received from Mr. George E. de Silva, M.S.C. and Mr. R. C. Kannangara, M.S.C.

MINUTES

Draft Minutes of the thirty-sixth meeting which had been circulated to Members were confirmed and signed by the Chairman.

APPLICATION FOR GRANT FROM THE DEPARTMENT OF INDUSTRIES

The Chairman reported that a letter and memorandum on the facilities available for training students which had been submitted to Board members for approval by circulation of papers, had been forwarded to the Minister for Labour, Industry and Commerce. No reply had yet been received.

Arising from consideration of the memorandum it was decided to re-appoint a Budding Instructor owing to the large demand for training of estate employees in budgrafting. It was arranged that the former instructor who had been transferred to other duties in 1935 owing to lack of demand for training in budgrafting, should be detailed for the work and a temporary officer appointed to undertake his present duties.

ACCOUNTS

(*a*) *Statements of Receipts and Payments of the Board and the London Advisory Committee for the quarter ended* 31*st December*, 1936—were adopted.

(*b*) *Dartonfield and Nivitigalakele accounts for December*, 1936 *were tabled.*

(*c*) *Supplementary Votes for* 1936.

Supplementary votes totalling Rs. 3,172·00 were passed to cover over-expenditure of 1936 votes, after consideration of the Director's explanations as stated in the Auditor's Report.

(*d*) *Income and Expenditure Account, Balance Sheet and Auditor's Report for* 1936.

The statement of accounts and auditor's report which had been circulated to members, were adopted.

(*e*) *Revote of balances of votes on capital account unexpended in* 1936.

Revotes totalling Rs. 20,434·00 were approved after consideration of the reasons for non-expenditure of the entire votes in 1936.

(*f*) *Fixed Deposits.*

Renewal of the following deposit was reported :—

Rs. 30,000·00 at the Chartered Bank of India, Australia and China for 1 year at $1\frac{3}{4}$ per cent.

It was decided that the funds standing to the credit of the Provident Fund account and now on fixed deposit should be transferred to an investment carrying better interest. Mr. C. H. Collins (Acting Financial Secretary) agreed to advise on the nature of the investment.

REPORTS

(*a*) *Annual Report for* 1936.

The Report for 1936 was adopted subject to minor amendments and it was decided to publish the report as in previous years.

(*b*) *Technical Officers' Reports for the Quarter October/December*, 1936.

Adopted.

(*c*) *Mr. R. K. S. Murray's report on visit to Malaya and Netherlands East Indies.*

It was decided to publish the report as a bulletin and in the meantime it was agreed that advance copies should be forwarded to Agency Houses and to the Planters' Association of Ceylon, The Ceylon Estates Proprietary Association and the Low-Country Products Association.

The Board decided to record its appreciation of the thorough and efficient manner in which Mr. Murray had fulfilled the purpose of the mission and to thank him for his very interesting report.

(*d*) *Visiting Agent's Report.*

1. It was decided to adopt the recommendation to manure half the estate annually.

2. In the course of discussion on decrease of crop in 1936 a suggestion was made that tapping was too shallow at Dartonfield and on other local estates. Mr. Murray had commented in his report on the greater attention which is given to this point in other producing countries. The Director was asked to consider the advisability of preparing a leaflet on the subject.

3. It was agreed that yield figures from the area set aside for study of forestry cultivation should be shown separately in the Estate Superintendent's reports.

STAFF

(*a*) *Technical Staff Requirements.*

Arising from preliminary discussion of the subject at the previous meeting, the Chairman stated that a memorandum had been circulated to members showing the financial position of the Scheme and the additional expenditure which would be incurred if it was decided to appoint a Soil Chemist and a Geneticist.

Members agreed that both appointments were urgently necessary if funds were available. After considerable discussion it was decided that the financial position did not warrant the appointment of both officers at the present time and it was decided to appoint a Geneticist.

It was agreed to advertise the vacancy locally and abroad on the terms of service and salary scales previously approved, with initial salary according to qualifications and experience. The Chairman was authorized to take all necessary steps in connection with the appointment.

(*b*) *Nivitigalakele Conductor.*

The appointment of Mr. M. Thursen de Silva was reported and approved.

SULPHUR DUSTING SCHEME

The Chairman reported that a letter had been received from the Minister for Agriculture and Lands stating that the scheme should be wound up and the balance of the grant refunded to the Rubber Restriction Fund if the Board considered that it had fulfilled its duties in relation to the control of oidium.

In accordance with the letter the dusting machines had been sold by public auction realising an average price of Rs. 355·00 which was considered satisfactory. A statement of receipts and payments was submitted showing a surplus of Rs. 7,166·36 and it was agreed that the amount should be refunded to the Rubber Restriction Fund.

EXPERIMENTAL COMMITTEE

The following decisions were reached regarding recommendations of the Committee.

(*a*) *Visiting Agents' Reports.*

Three visits to be made annually as at present but only one comprehensive report submitted.

(*b*) *Supplementary votes for buildings in* 1937 *programme.*

Owing to increases in the price of building materials it was decided to increase the votes by 5 per cent. A sum of Rs. 2,800·00 was voted for the purpose.

(*c*) *Estate Office.*

It was agreed that the estate office should be of the same type as the other buildings and the vote was increased from Rs. 2,500·00 to Rs. 4,000·00.

(*d*) *Water Pumping System.*

A sum of Rs. 1,283·00 was voted for the purpose of purchasing spare parts.

(*e*) *Power and Water Supply for Nivitigalakele.*

A sum of Rs. 2,750·00 was voted for the installation of a generator and pump.

PUBLICATIONS

Consideration was given to a suggestion that an advertisement should be issued in the local press reminding estates of the need for annual renewal of registration.

After discussion it was decided that publications should be issued free of charge to Proprietors (resident in Ceylon), Superintendents and local Agents of Rubber estates of over 10 acres in extent who apply for registration, without the need for annual renewal of registration. In the case of large estates additional copies of publications should be supplied if required for the use of Assistants.

REVIEW

Vegetative Propagation of Tropical and Sub-Tropical Fruits.

Compiled by G. St. Clair Fielden, B.A.—Imperial Bureau of Fruit Production, Technical Communication, No. 7. Price 2 shillings.

THIS Technical Communication could not have appeared at a more opportune moment than the present which marks an era of horticultural awakening throughout many tropical countries.

Sir Geoffrey Evans in a foreword refers to the great potential demand that is likely to arise for standard varieties of tropical fruits as developments in cold temperature research make it possible to market high quality fruit at reasonable prices in the vast industrial areas of the temperate zone.

There are of course local markets in the tropics which can absorb appreciable quantities if the population is educated to the high dietetic values of fruit and if production and distribution are so organised as to ensure regular supplies of quality fruit at prices within the reach of the large majority.

It will be necessary as the taste for tropical fruits is acquired and markets expand to open new orchards and plant standardised material that will yield fruit of uniform high quality ; and it is here that methods of vegetative propagation will be of invaluable aid to the grower to multiply existing varieties and possibly to fix the desirable types that arise by chance variation as bud sports or mutants.

There are well-known and accepted standard methods, many having stood the test of time in temperate countries, of which a lucid account with illustrations in neat line drawings, is given in the first part of the publication.

The method of inarching by approach, though slow and cumbersome, has been practised from time immemorial in India and North Ceylon, and to it we probably owe the existence of such wide range of famous varieties of that exquisite tropical fruit—the mango : the method is however being superseded locally by budding and by wedge grafting.

Mention must also be made of the Forhert method of budding evolved by the Dutch in Java in comparatively recent times to suit their particular needs, but which has now more or less given place to the modified Forhert system.

It seems there can seldom be any hard and fast rule as to the choice of a method of propagation for any particular fruit owing to the many and variable factors which contribute to success in the Tropics. As a case in point in Ceylon

the mango can be propagated quite successfully by wedge grafting in the more humid areas of the wet zone, while in the dry zone budding appears to give better results. Propagation methods may have to be modified to suit particular conditions and many tropical countries have begun to carry out sustained experiments to determine whether any modification of standard practice will be acceptable on a wide scale as a commercial proposition.

The purpose of this communication has been to present a concise account of the results of such trials on a wide range of tropical and sub-tropical fruits which have been carried out in various countries and reported in scientific publications and in the answers to queries from the Bureau. It is not too much to say that in this the Compiler has achieved his object and all credit is due to him for the manner in which the information is presented under appropriate headings, for a large number of fruits arranged in alphabetical order according to their botanical names, and also for the list of references giving the source of information.

Citrus is not included since it has already being the subject of Technical Communication No. 3 of 1932.

It is gratifying to learn that a similar bulletin on perennial tropical and sub-tropical crops other than fruit is to appear in due course.—T.H.P.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MARCH, 1937

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1937	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	53	34	41	..	12	..
	Anthrax	..	..	..	..	..	..
	Rabies	4	1	..	..	..	4
Colombo Municipality	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	338	248	292	5	41	..
	Anthrax	7	..	..	7	..	..
	Rabies	7	2	..	7*	..	..
Cattle Quarantine Station	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	1	..	1	..	..	..
	Anthrax	9	6	..	9	..	..
Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	64	..	64	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies	..	..	..	..	..	..
	Piroplasmosis	1	..	..	1	..	..
Southern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
Northern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	858	440	560	37	261	..
	Anthrax	..	..	..	..	..	..
Eastern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	61	..	61	..	..	..
	Anthrax	..	..	..	..	..	..
North-Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	2	2	1	..	1	..
	Anthrax	..	..	..	..	..	..
	Rabies	2	..	..	..	..	2
North-Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	22	..	22	..	..	..
	Anthrax	..	..	..	..	..	..
Uva	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	131	43	115	3	13	..
	Anthrax	..	..	..	..	..	..
	Rabies	2	2	..	..	..	2
Sabaragamuwa	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Piroplasmosis	4	..	3	1	..	..

*All destroyed.

Department of Agriculture,
Peradeniya, 19th April, 1937

M. WIJAYANAYAKA,
Acting Government Veterinary Surgeon

METEOROLOGICAL REPORT—MARCH, 1937

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	87·2	−0·5	74·3	+0·5	72	93	4·4	6·48	11	+ 1·61
Puttalam ..	89·0	−0·6	72·3	0	69	93	3·0	0·73	3	− 2·60
Mannar ..	89·0	−0·9	75·1	+0·1	68	86	3·5	0·89	3	− 0·83
Jaffna ..	88·2	−0·2	75·6	+0·3	69	86	5·0	1·20	5	− 0·63
Trincomalee ..	85·1	0	75·6	−1·0	72	86	3·9	2·41	5	+ 0·05
Batticaloa ..	85·3	+0·2	74·8	−0·1	73	90	4·7	2·58	6	− 0·77
Hambantota ..	87·5	+1·1	73·5	−0·5	72	90	3·1	2·93	9	− 0·90
Galle ..	86·9	+0·5	75·7	+0·8	72	88	4·0	1·47	6	− 4·74
Ratnapura ..	92·4	+0·6	72·5	+0·1	70	93	5·1	14·81	17	+ 3·86
Anuradhapura ..	90·2	−0·4	71·6	+0·1	64	95	4·4	6·32	8	+ 2·68
Kurunegala ..	92·2	+0·2	71·5	−0·2	62	90	3·3	7·42	10	+ 1·44
Kandy ..	89·2	+2·0	67·0	−1·6	63	92	4·4	7·02	10	+ 1·19
Badulla ..	82·4	+0·5	63·5	−0·8	65	89	3·6	4·53	8	− 1·04
Diyatalawa ..	76·9	+0·1	57·3	−0·6	62	80	4·2	3·09	7	− 1·86
Hakgala ..	73·6	+1·8	51·0	−0·9	63	87	5·1	5·61	8	− 1·09
Nuwara Eliya ..	71·6	+1·2	44·4	−2·0	63	93	6·0	3·75	9	− 0·57

The rainfall of March was generally below normal. Excesses and deficits were somewhat irregularly distributed, excess being most marked among the western foothills and the low-country districts immediately adjoining.

The highest monthly total was 20·03 inches, at Udahena, and totals over 15 inches were also reported from Digalla, Keragala, Carney, Maliboda and Lunugala. 5 daily falls of over 5 inches were reported, the highest being 6·14 inches, at Mawarella, on the 20th.

The dry spell which set in at the end of February continued for the first week in March, practically no rain being reported. The humidity was generally low, particularly up-country, and night temperatures were usually below normal. The tendency to rain then increased a little, while from the 11th till nearly the end of the month the weather was of the typically intermonsoon type, with flat pressure gradients and local afternoon or evening thunderstorms, chiefly in the south-west of the Island. About the end of the month there were a few days with very little rain.

Low-country temperatures showed no marked deviations from normal. Up-country, however, maximum temperatures were above normal, and minimum temperatures below, giving a diurnal range above the average. Humidity was on the whole about normal, while cloud was in deficit. Barometric pressure was below normal. The wind was generally above normal strength, and of variable direction.

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